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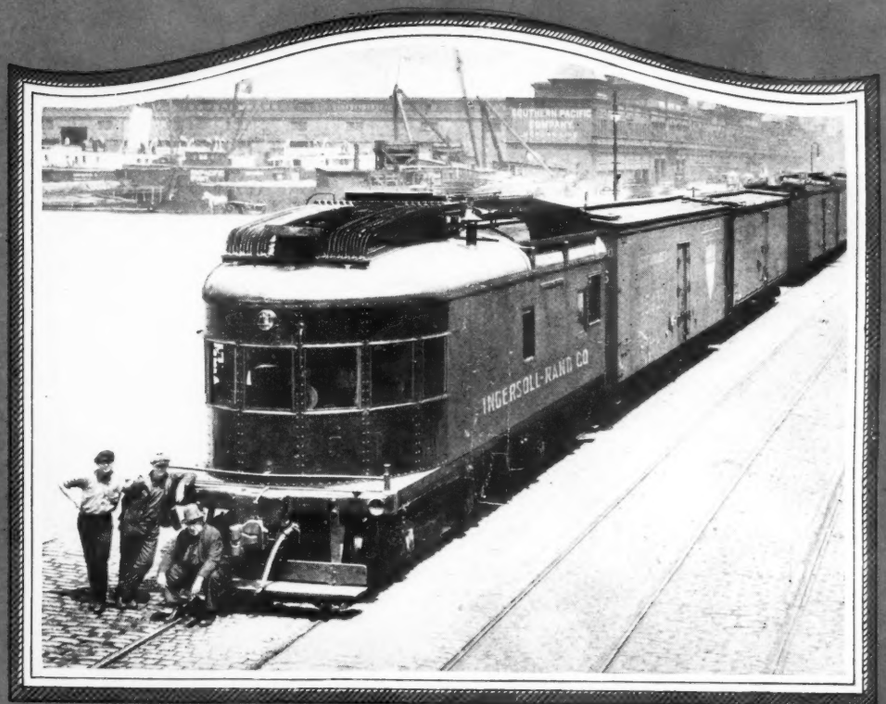

OIL-ELECTRIC LOCOMOTIVE FOR GENERAL RAILWAY SERVICE IS AN ACCOMPLISHED FACT

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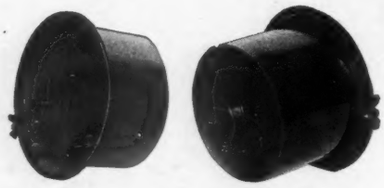

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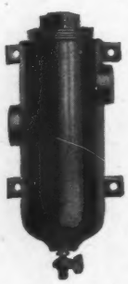

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Liquid-Oxygen Explosives in Epoch-Making Blast

Forty-five Hundred Tons of Rock Lifted in a Pennsylvania Quarry With Less Than Eight Hundred Pounds of the New Explosive

By F. W. O'NEIL

NEARLY 98,000,000 tons of stone for crushing, for furnace flux, for rubble, for riprap, and for various other purposes was produced by our numerous quarries during the year gone. This output represented a substantial increase over that of 1922; and the upward trend continues in this field of industry, which contributes to many needs.

Plainly, the blasting of rock is a much bigger business in this country than most people realize. To shatter and to dislodge this rock from the ledge requires every twelvemonth the use of millions of pounds of powerful explosives. For this work dynamite is extensively employed.

It is self-evident that substantial economies would result if the quarryman had at his command a cheaper and an equally effective blasting agent—in short, one that would answer as well as dynamite and have, besides, some distinctive merits which would make its adoption especially desirable. Happily, such a medium is to be had in L. O. X.—the accepted abbreviation for liquid-oxygen explosives.

Off and on in this country, both the technical and the popular press have had something to say about this kind of explosives; and a fair percentage of the public is aware that liquid-oxygen explosives were brought to a commercial stage of usefulness mainly through the exigencies of war and the enforced efforts of certain of the European belligerents to conserve their precious stocks of fixed nitrogen.

These informed people also know that L. O. X. has been retained since the cessation of strife as a substitute for dynamite in some important mines abroad, and they are familiar with the fact that the performances of these explosives have been decidedly satisfactory and of much suggestive value. On the other hand, relatively few persons have yet learned that American experts, after much research, have brought the art of manufacturing liquid-oxygen explosives to a more advanced stage than that attained abroad, and are now in a position to give our quarrymen and our mine operators the benefit of these improvements. Probably, the measure of this progress can be better understood if we describe a demonstration made recently at a quarry in Pennsylvania. That blast has made it possible for us to draw a direct comparison between the performances of dynamite and L. O. X. when tested under similar service conditions.

LIQUID oxygen was for years scarcely more than a laboratory curiosity because of the somewhat complex facilities required in its making. Today, liquid oxygen can be made on a commercial scale and in large quantities by machinery and apparatus built for that purpose; and its applications in industry bid fair to increase and to grow in importance as the years go on.

The accompanying article deals with a significant adaptation of liquid oxygen—its use in producing a powerful new explosive called, for the sake of brevity, L. O. X. This explosive is both cheaper and safer and, pound for pound, considerably more effective than dynamite. What we have to tell about L. O. X. should be of outstanding interest to quarrymen and to others engaged in blasting operations.

On March 5 of the current year, some preliminary blasting was done with L. O. X. at Myerstown, Lebanon County, Pa., on the property of the Calcite Quarry Company; and as a consequence of the excellence of that showing the quarry company gladly assented to a second demonstration. The latter was carried out on April 11 by officials of the Air Reduction Company and the Ingersoll-Rand Company who had had to do not only with the designing and the construction of the plant which furnished the liquid oxygen but who also worked out the details for the application of L. O. X. to the blasting of churn-drill holes. It is hardly necessary for us to emphasize that success depends largely upon the get-up of the cartridge. Among the interested spectators were representatives of the mining and quarrying industries as well as others who have to do with the use of explosives.

The object of the second demonstration was to conduct a complete blast in accordance with the usual procedure followed by the Calcite Quarry Company in its routine operations. This took the form of a 12-hole blast on a 30-foot bench which was located at one end of the quarry. The drill holes were spaced about 12 feet apart, as indicated by one of the accompanying illustrations; and each of these holes was 28 feet deep and 5½ inches in diameter. The cartridges were 5 inches in diameter and 18 inches long—five of them being placed in each hole. For stemming, loose loam was poured into the holes; and none of this material was tamped.

The cartridge cases or bags were made of stout muslin and filled with finely divided carbonaceous material which was of a highly absorbent nature. Before soaking in the liquid oxygen, each dry cartridge, in its complete form, weighed 3.25 pounds—the entire lot of 60 cartridges used in the blast weighing in this state 195 pounds. As has been determined, each unit of carbon requires for its complete combustion to CO_2 a total of 2.66 units of oxygen. However, the ratio of absorption in the case of the cartridges employed at Myerstown was 3.5 units of oxygen—the excess oxygen allowing a correspondingly longer period in which to load the holes and to make other preparations before evaporation brought the explosive to the CO_2 point. Indeed, the CO_2 point can be passed without materially diminishing the force of the explosion. As a matter of fact, explosive action with cartridges of the kind in question can be obtained any time within two hours after they have been saturated and placed in the drill holes ready for detonating.

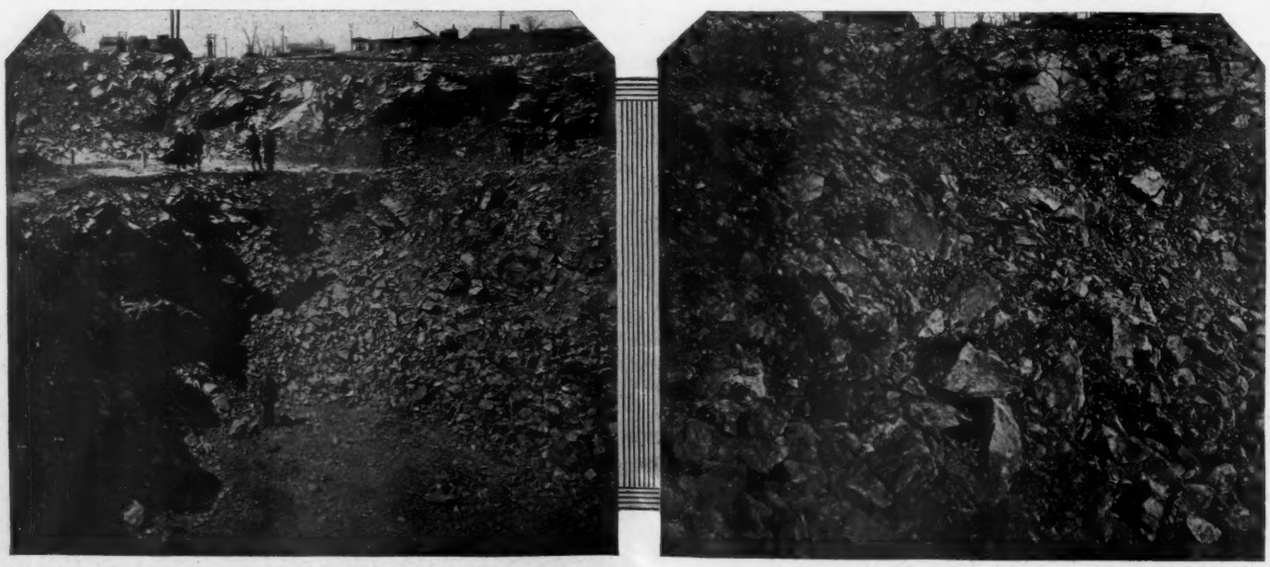
The liquid oxygen required for the demonstrating blast was delivered at Myerstown in

Photograph of the blast taken just before the uprush of dust reached its greatest height. The cloud is not smoke but the red loam which was used for stemming the twelve drill holes.

forty 15-liter transportation bottles—the outward character of which can be seen in one of our illustrations. These containers are so constructed that they minimize evaporation of their liquid-oxygen content while in storage or in transit. When filled and ready for shipment, early in the evening of April 7, the net weight of oxygen in the bottles amounted to 1,541 pounds. When the containers reached their destination in the forenoon of April 11, they held a total of 1,014 pounds of liquid oxygen—representing a loss of 527 pounds or 34 per cent. during a transportation period of 88 hours. In other words, there was sustained by evaporation a loss of 9.3 per cent. for each 24 hours.

When the soaking of the cartridges was begun there was available, therefore, 1,014 pounds of liquid oxygen. Sixty-one cartridges were soaked although but 60 of them were actually utilized for the blast. When the soaking of the entire lot was completed there remained unused 93 pounds of liquid oxygen—that is to say, each cartridge absorbed substantially 15 pounds of the fluid, and the whole lot required 921 pounds for their saturation. The theoretical weight of oxygen needed for 61 cartridges, based upon the 2.66 ratio per unit of carbon, is 525 pounds; and, therefore, the oxygen factor in this demonstration was 1.75—this figure being obtained by dividing 921 by 525. As can be seen, an excess of 75 per cent. of liquid oxygen was used over that necessary to insure the cartridges being above or at the CO_2 point after the lapse of a considerable period following their withdrawal from the soaking vessel.

The soaking vessels used abroad are not large enough to accommodate at one time more than a single cartridge of the size fired at Myerstown—the European cartridges being much smaller. This restriction is objectionable, as any practical man can readily appreciate, because of the time that would be required to soak a large enough number of cartridges to meet the needs of a sizable round. To overcome this difficulty, and to make it feasible to soak simultaneously twenty or more cartridges, an insulated tank was built for



Left—Corner of the quarry and the bench before the blast of L.O.X. was set off. Right—Close-up showing the manner in which the 60 cartridges lifted and shattered 4,500 tons of rock.

the quarry demonstration. This was a double-walled, box-like affair having the interspace filled with felt and the soaking chamber lined with copper. One of our photographs plainly shows the somewhat simple character of this tank. The container proved entirely satisfactory; and the loss of liquid oxygen by evaporation was surprisingly low.

The cartridges were soaked in the liquid oxygen for about 30 minutes. In the first lot by 3.05 o'clock. All twelve holes were shot in unison at 3.35. There was intentionally a lapse of 30 minutes between the time the cartridges were in place in the twelve holes and the moment of firing. In fact, there was a total interval of 1 hour and 35 minutes from the moment the first of the cartridges were taken out of the liquid oxygen until the blast was set off. This point is an important one, for it emphasizes that large quantities of common trunk—a single cap on the trunk fuse serving to set off all the charges at the same instant when detonated electrically. According to officials of the Calcite Quarry Company, for a similar blast under ordinary conditions they would use 85 pounds of 40-per cent. dynamite in each hole, or a total of 1,020 pounds.

It was estimated that 4,500 tons of rock were broken by the blast or 6.2 tons per pound of L. O. X. employed. Had 1,020 pounds of

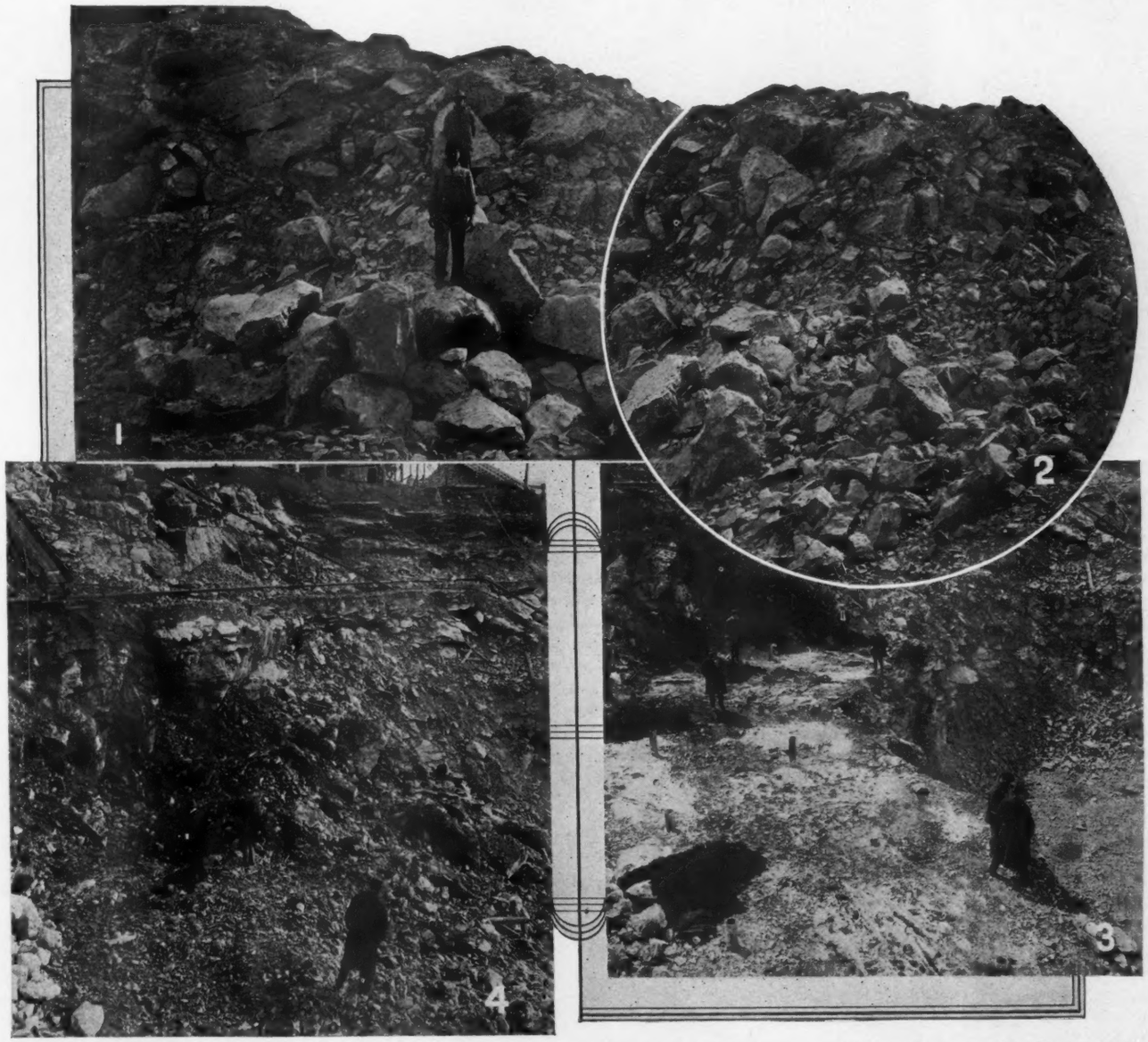


Fig. 1—Large pieces of rock which were blockholed and blasted with small cartridges of L.O.X. Fig. 2—This shows how effectually the blockholed rock was blown into small pieces. Fig. 3—The bench before blasting. Projecting collars show where the twelve holes were located. The dark patches are red loam used for stemming. Fig. 4—What the blast of 60 L.O.X. cartridges did to the bench. The two figures at the left of the center are looking down into a pronounced crater created by the explosion at the rear of the bench.

35 of them were so dealt with—enough to load seven holes. Then a second batch consisting of 25 cartridges was soaked, and when ready these were used to load the five holes remaining. The time intervals were as follows: Started to withdraw the first batch of cartridges from the liquid at 2 P. M.; and the first set of seven holes was completely loaded by 2.30. Started to soak the second batch at 2.20; and the remaining five holes were loaded L. O. X. can be used for a single blast and ample time allowed for the deliberate placing of the cartridges, for doing the needful stemming, and for making what other arrangements may be necessary to insure thoroughly effective results.

To fire the 60 cartridges, there was hung in each hole from top to bottom a suitable length of TNT Cordeau; and the twelve lengths of Cordeau were connected above ground to a dynamite been used instead and a like quantity of rock broken, this would have meant 4.4 tons of rock for each pound of explosive. It was the judgment of those in charge of the demonstration that the blast was overshot and that the same result could have been obtained with 20 per cent. less L. O. X.

After the blast, about fifteen sizable boulders were blockholed—using in each boulder a cartridge 1¼ inches in diameter and 5 inches

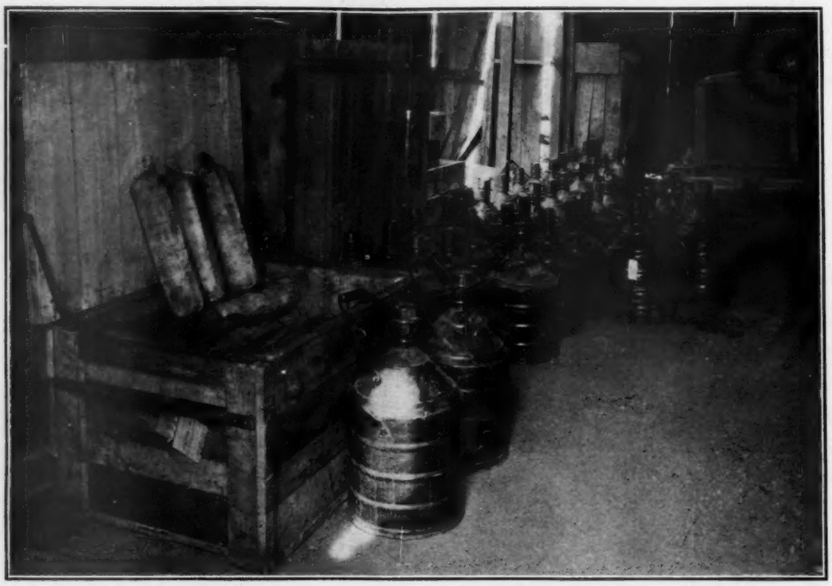
long. The explosive broke up the boulders into small fragments. It was conclusively determined that L. O. X. cartridges cannot be detonated in the open air by a fuse but that they will, instead, burn rapidly with a bright flame. This was proved by placing a few cartridges in the open and setting them off with fuses.

Now let us consider the monetary significance of the main performance. Assuming the total weight of the 60 cartridges to be 721 pounds at the CO_2 point, and putting the cost of the L. O. X. at 8 cents a pound—which is ample to cover fixed charges and loss by evaporation—then the total outlay for the liquid-oxygen explosive amounts to $57.68. On the other hand, with dynamite at 13.25 cents a pound and 1,020 pounds of it needed, the bill for this explosive would be $135.15. At these rates, the expenditure for L. O. X. for each ton of rock broken was 1.28 cents, while the use of dynamite for the same service would have cost 3 cents. In short, the cost of L. O. X. amounts to but 42 2/3 per cent. of that of dynamite. If the assumption be correct that the blast was overshot to the extent mentioned, then the outlay for L. O. X. for a specific performance can be put at 34 per cent. of that of dynamite.

A marked feature of the effect of the blast was a somewhat pronounced crater formed at the foot of the quarry face when the bench was lifted. This cavity served admirably to indicate the downward force exerted by the L. O. X.; and the measure of this reaction is especially noteworthy when it is recalled that the loam used for stemming was not tamped at all but merely poured into the holes. This stemming was a red clayey earth which photographed black in some of the pictures; and the dust from this stemming was responsible for the density of the cloud blown skyward at the time of the blast.

The liquid oxygen used in this significant demonstration was produced by a plant operating under the Claude system—the system adopted by the Ingersoll-Rand Company for the manufacture of liquid oxygen in large quantities. This system has been developed by the renowned French physicist, Dr. Georges Claude; and one of the distinctive characteristics of it is that it is necessary to compress atmospheric air to only 1,000 pounds or possibly less to produce liquid oxygen. By other systems in use, the air must be subjected to an initial pressure of 3,500 pounds before liquefaction is accomplished. The greater efficiency and economy of the Claude process should, therefore, be self-evident.

The L. O. X. blast at Myerstown was the first of its kind on a commercial scale ever made in a quarry in the United States; and there are the best of reasons for believing that it was the largest blast of liquid-oxygen explosives so far set off anywhere. It was the climax of much work, and marked the overcoming of many obstacles.

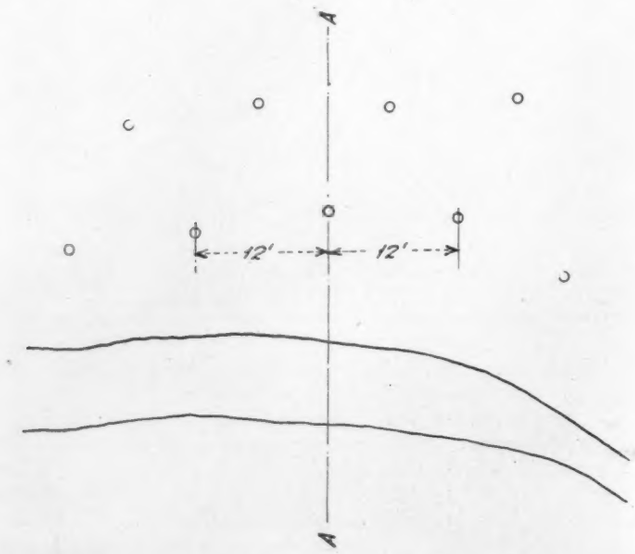


Soaking tank, some of the big cartridges, and a number of the special transportation bottles in which the liquid oxygen was delivered at Myerstown after a journey of 88 hours.

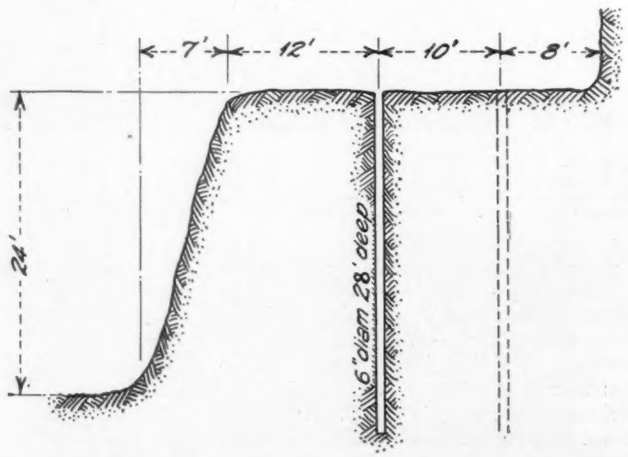
DEEP-SEA DIVING FOR GELATINE

NEW sources of food gelatine have been developed in Lower California, where great quantities of seaweed are being treated and reduced to a very clear and nearly tasteless vegetable gelatine of high quality. In recent years, small quantities of seaweed have been gathered there from time to time and shipped to the United States; but now the industry appears to be assuming larger proportions.

The weed gathered is known as *Gerldcum;* and as many as fifteen varieties exist along the Lower California coast. It grows at varying depths from one to ten fathoms or even deeper, and always on rocks—never in sand. It is gathered by divers working under scientific methods with air pumps and diving bells. The weed is first dried in the sun, boiled, and then exposed to a freezing temperature. Next, the water content is evaporated by exposing the product to the sun or artificial heat, leaving the gelatine of commerce.



Plan of bench and arrangement of the drill holes.



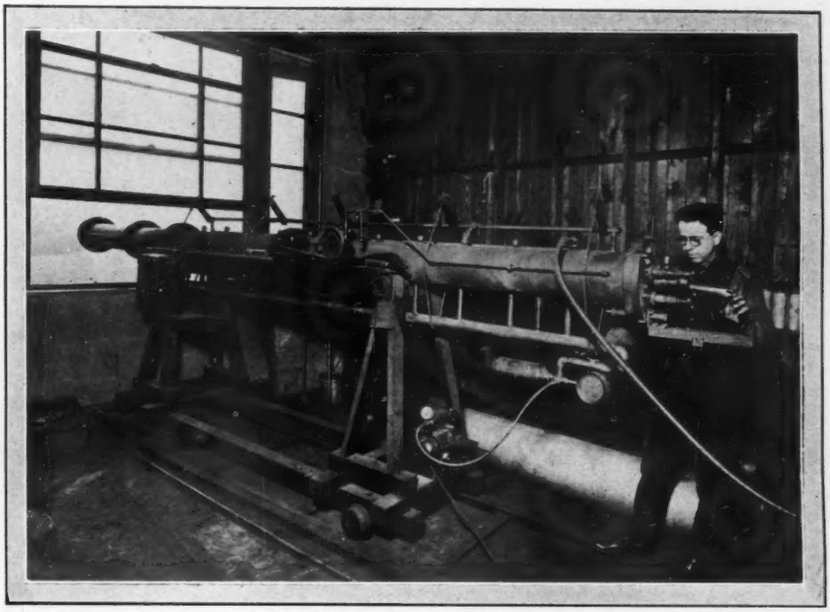
Vertical section through bench at A-A.

Spreading Stone Dust With Compressed Air to Prevent Coal-Dust Explosions

By C. MORAN

NINETEEN explosions, causing the loss of 530 lives and millions of dollars worth of property, have occurred in our coal mines during the past six years, and substantially all these disasters were confined to bituminous collieries and were attributable to coal dust.

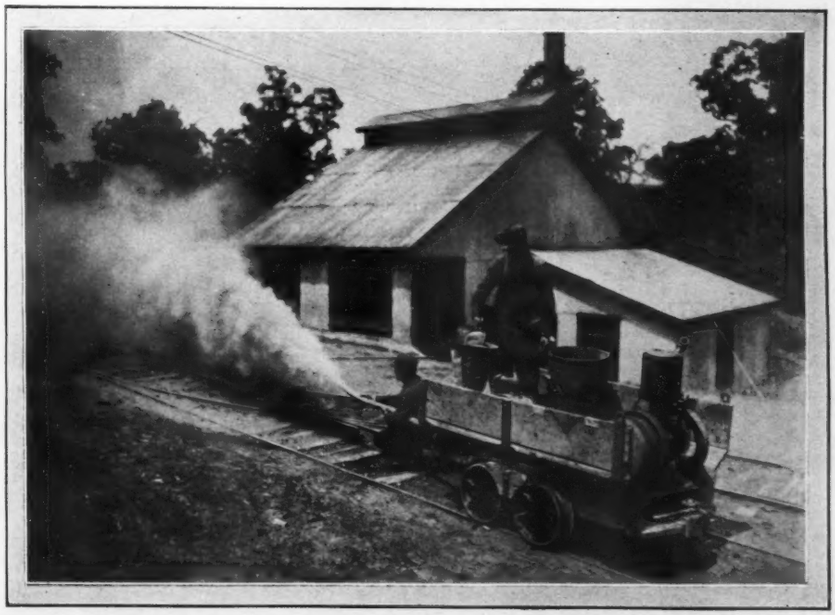
In their effort to check coal-dust explosion, investigators of the United States Bureau of Mines found that watering is an effective preventative when done regularly and thoroughly, but comparatively few mines have adopted this system. Casting about for some other method, they discovered that by spraying the mine with rock dust the coal dust is rendered nonexplosive. With this fact established, the first step was to determine the relative explosibility of various coal dusts. To this end, samples of coal dust from all over the world have been tested by "firing" them in a rather unique cannon, shown in an accompanying illustration; and with the information so obtained it is possible to tell just what admixture of stone dust is needed to prevent an explosion.



Gun devised by the experts of the United States Bureau of Mines for testing the relative explosibility of different kinds of coal dust.

The work of firing is done as follows: Samples of coal dust are placed in the series of five nipples connecting the cannon proper with the smaller pipe underneath, through which compressed air is forced at a pressure of 100 pounds; and pieces of guncotton are inserted at intervals of a few inches along the bore. When all is in readiness, the operator, with his right hand, releases the compressed air that blows the coal dust into the cannon, and an instant later, with his left hand, fires a shot of gunpowder. The mild explosion that follows ignites the guncotton; and the length of the flame, which is also an index of the menace of the coal dust, is measured by the number of pieces of guncotton ignited.

When the explosibility of the coal dust is known, then the management of the mine from which the sample was taken is given detailed instructions as to the kind and the quantity of rock dust required to make the coal dust nonexplosive. Many sorts of rock dust have been found suitable for the purpose, notably limestone and light-colored, clayey shale free from flinty particles that might be injurious to the health of the miners.



Mobile compressor plant adapted to the distribution of rock dust as a means for preventing coal-dust explosions.

Numerous methods of distributing rock dust throughout mine workings have been developed. One of these is a type of ejector, which is coupled by a hose to a compressed air main and draws its supply of stone dust from a car through a pipe or hose. A variation of this is an ejector, likewise linked up with the permanent air line and having one of its legs standing in a car of stone dust. The effective reach of this system depends on the frequency of the available air connections and on the length of hose that can be conveniently carried. With this arrangement, traces of stone dust have been found in workings three-quarters of a mile away from the point of distribution.

Yet another method employs a system of 1-inch or 2-inch air piping having connections spaced 50 yards apart. Before beginning operations, bags of stone dust are deposited at intervals along the mine roadway. The men in charge start at the outby end with a bag or two in a mine car and, with the blower coupled to the nearest compressed air tap, dust the roof, sides, and floor as the car moves along. When they have gone as far as the 25-yard length of flexible hose permits, they simply shift it to the next nearest convenient connection in the air line.

Various other mechanical and hand methods have been devised and are employed for this service, the value of which is being recognized in the coal-mining industry. While it has not yet been widely adopted in the United States, operators of collieries in southern Illinois claim that "rock-dust barriers

have prevented many coal-dust explosions, started by local explosions of fire damp or by shot firing, from propagating beyond the barrier in the mouth of the panel in which the explosion originated." The managements of other mines, in which disastrous coal-dust explosions have occurred despite watering, are now considering the adoption of rock dusting.

Tests conducted in the experimental mine of the United States Bureau of Mines have shown that pure, fine, bituminous coal dust will propagate an explosion even when it carries 25 per cent. water. The mere wetting of the floor and sides is not enough to halt an explosive wave if coal dust lies on timbers, in overhead cavities, or on ledges within reach of the concussion preceding the flame. To keep long haulage roads and old workings thoroughly wet all the time is decidedly difficult because of the rapidity with which moisture evaporates or sinks into the ground. Moreover, it is a hard proposition to wet fresh coal dust. When undisturbed, coal dust will float so thickly on water for long periods that the top layer may be fanned into the air.

After rock dusting, many roadways do not have to be gone over again for a week or two, and other parts of the mine may not need redusting for months. Light-colored dust is visible, and has the added advantage of greatly increasing rather than decreasing the illuminating effect of a miner's lamp. Wetting intensifies the blackness of the walls. More light in the passageways tends to lessen the number of minor accidents.

An official mission from Great Britain, where stone dusting has now been well-nigh universally adopted, recently visited the United States to arrange with the Bureau of Mines for joint research work in this field of effort. A series of coal-dust-explosion tests, made for the foreign investigators in the experimental mine at Bruceton, Pa., revealed that British Silkstone coal dust is similar to Pittsburgh coal dust and requires about the same amount of inert or rock dust for the purpose of safeguarding against the hazards of coal-dust explosions. Meetings with mining men were held in Pennsylvania, West Virginia, and Illinois, at which members of the British mission explained the methods of rock dusting used in Great Britain. The mission consisted of Prof. R. V. Wheeler, Director of the British Mines Explosion Experimental Station at Eskmeals; Henry Walker, Deputy Chief Inspector of the Mines of Great Britain; and W. R. Chapman, scientific assistant to Professor Wheeler.

Rock dust is so carried on overhead shelves and on top of lateral rails in some coal mines that the air wave preceding an explosion will shake down the dust and form a barrage against the progress of the following explosive flame.

New York City officials demonstrating pneumatic paving breakers at the formal opening recently of the yards of the Municipal Works Department. Julius Miller, President of the Borough of Manhattan—at right—and Joseph Johnson, Commissioner of Public Works, are handling the tools. Paving breakers of this sort are employed extensively in the upkeep of the streets of the Metropolis.

The biggest floating dock in the world, capable of accommodating the largest ship afloat, was safely berthed at Southampton during the latter part of April. It was built on the Tyne, Scotland, for the Southern Railway Company, and its principal dimensions are: lifting power, 60,000 tons; length, overall, 960 feet; height of side walls, overall, 70½ feet; clear width of entrance, 134 feet; and depth of water required, 65 feet. The net weight of the completely equipped dock is about 18,000 tons, including 16,200 tons of steel. The dock was put in commission in June.

MAKING THE WHISTLE PAY FOR ITSELF

THE whistle is a highly responsible appurtenance of the locomotive, and heretofore not enough attention has been given to it and to its installation to the end that it might give the most effective and reliable service. A rather thorough and unusual investigation of locomotive whistles has recently been made by Prof. Arthur L. Foley of the University of Indiana. His researches have brought out many interesting things which are of importance and not generally known or appreciated.

Doctor Foley has made a study of sound intensities, and he claims that a low-pitched whistle is only about one-sixth as effective as one of high pitch. The present location of the whistle on the engine is also about as bad as it could be. The reach and the effect of the whistle, it is explained, are unnecessarily retricted because of the smokestack, bell, steam dome, generator, and blanket of hot gases in front of it. These cause the sound to be broadcasted to the side of the track and not forward on the line. Doctor Foley has calculated that 2,434,026 tons of coal, costing $7,302,078, are consumed annually in the United States in generating steam to blow locomotive whistles. He maintains that two-thirds of this coal could be saved by higher-pitched whistles placed further forward on the steam locomotive.

Putting Through A Great Hydro-Electric Project in France

Water Power From the Upper Pyrenees to Furnish Electric Current for the Operation of Railways

EUROPE has been aroused during the last ten years to the need of utilizing more effectually the power latent in her falling waters. The fuel situation has added to this urge; and engineering cunning is bending its energies toward supplanting coal-burning power stations by hydro-electric plants wherever practicable.

The Gave d'Ossau, from which much of the power is derived, is a mountain torrent that furnishes a variable volume of water according to the season of the year. Therefore, the problem of the engineers has been to devise ways by which this decidedly flashy runoff could be controlled. The main river and its tributaries have their sources at an altitude of about 6,560 feet above sea level; and they flow through narrow and deep valleys which have been cut in formations of granite, hard schist, and limestone.

That portion of the valley along which the hydro-electric development traces its way has a very steep slope—the drop in the upper part being at the rate of fully 422 feet to the mile. Even in the lower portion of the valley, where the gradient is less abrupt, the drop amounts to 169 feet in the course of a mile. To take advantage of the total head, the project calls for three plants at three different levels and at strategic points which lend themselves to this purpose. The uppermost plant will be located where it can make use of the water impounded in Lake Artouste. This power station, to be known as the Artouste works, will be situated about 850 feet below the lake, which lies 6,429 feet above sea level. A dam built across the normal outlet of Lake Artouste has raised the surface of the water nearly 100 feet, so that the crest of this structure is at an altitude of 6,527 feet above the level of the sea. By means of this dam, the lake is capable of holding a matter of more than 6,604,000,000 gallons of water.

The Artouste plant has been designed for intermittent service and especially for the purpose of utilizing, during the dry season, the water held in reserve in this so-called annual reservoir. The lake will thus perform the double function of balancing and regulating the total output of the three stations of the

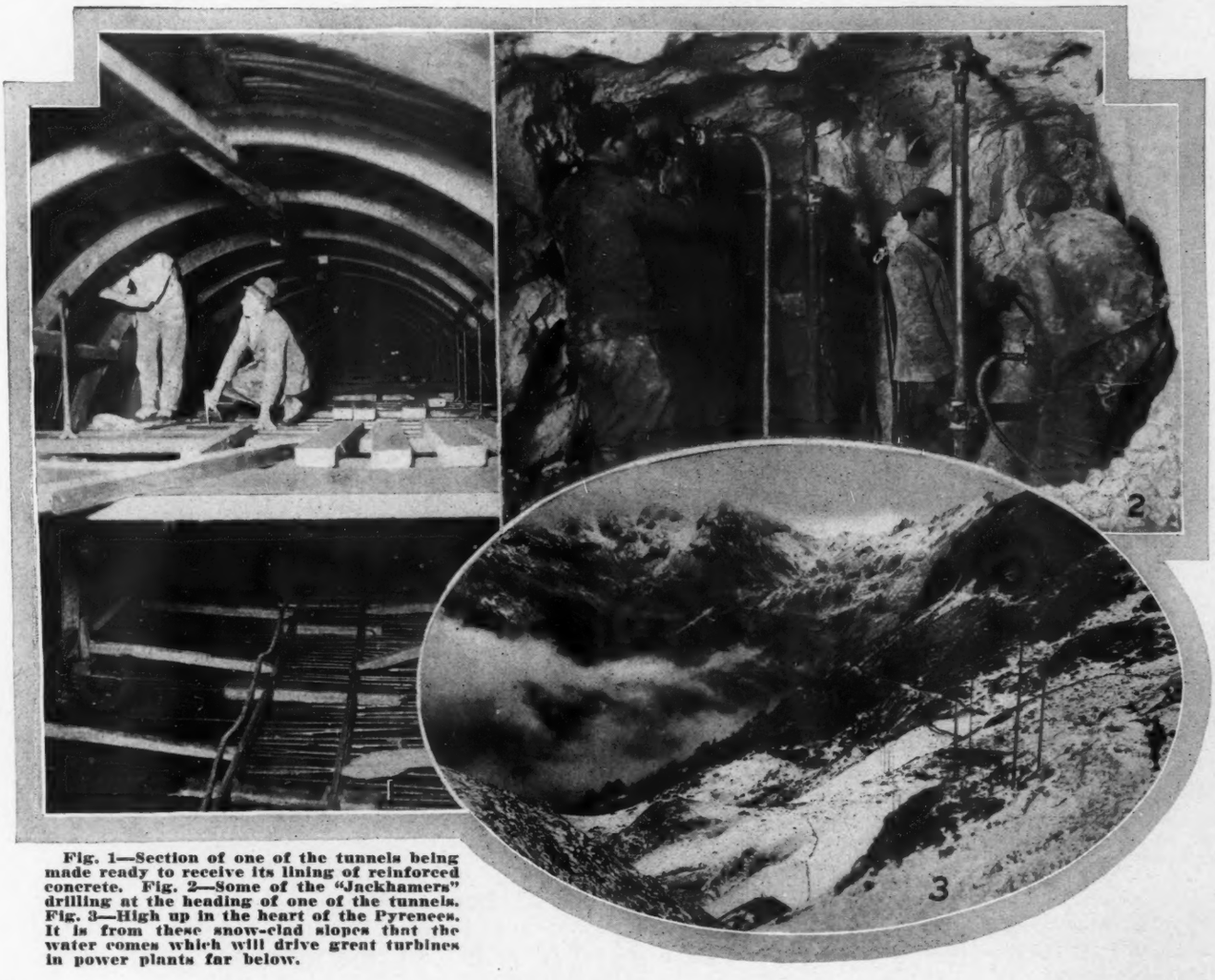


Fig. 1—Section of one of the tunnels being made ready to receive its lining of reinforced concrete. Fig. 2—Some of the "Jackhamers" drilling at the heading of one of the tunnels. Fig. 3—High up in the heart of the Pyrenees. It is from these snow-clad slopes that the water comes which will drive great turbines in power plants far below.

In this movement, the French are playing a conspicuous part; and they are wisely profiting by what has been done in the United States.

Among the projects of outstanding importance abroad is the hydro-electric development of the upper valley of Ossau; and the purpose of this ambitious undertaking, started in the summer of 1920, is to furnish current for the electrification of some of the lines of the Compagnie des Chemins de fer du Midi. As the name indicates, the railways concerned traverse that section of France which is largely contiguous to Spain and tributary to the region dominated by the Pyrenees.

system. From Lake Artouste, the water will be led a distance of nearly five miles through a tunnel, the lower end of which will discharge into three large penstocks of welded steel. These penstocks are to be 2,558 feet long and will lead the abruptly descending water to three Pelton turbines, each of which will be connected to a 10,000-H.P. generator. The dynamos are to deliver 3-phase, alternating current of 10,000 volts to transformers, in the station, which in their turn will raise the potential to 60,000 volts.

Next in succession comes the Miégebat plant, the site of which is 1,338 feet below that of the Artouste power house. This plant is to be equipped with five 10,000-H.P. generators—which will produce 3-phase, alternating current of 10,000 volts to be stepped up by transformers to 60,000 volts—and will be actuated by the water discharged from the upper plant and by the flow of two tributaries feeding into the Gave d'Ossau—namely, the Gave de Brousset and the Gave de Bious. The arrangement is such that a daily storage of nearly 2,400,000 gallons can be maintained; and the purpose of this storage is to take care of variations in the demand for current—these plants being intended primarily to furnish electricity for the operation of the railways. As in the case of the upper power station, the water will reach the Miégebat works after traversing a tunnel, 26,240 feet long, and thence passing through three steel penstocks, each to have a length of 1,312 feet.

And now we come to the lowest of the central stations, that designated as "du Hourat," situated substantially 700 feet below the Miégebat unit. This plant, the first to be completed, draws its energy from the water descending from the Miégebat installation, which is increased on the way by the flood from certain tributaries of the Gave d'Ossau—the most important of which is the Bitet. Provision is made for a 24-hour storage of enough water to meet the peak-load requirements of the plant. The water driving the turbines in the Hourat power house reaches those wheels after flowing through an underground conduit for a distance of about 18,700 feet and then descending a very sharp gradient through two big steel penstocks, each 656 feet long. In this plant are five 10,000-H.P. alternating generators producing 3-phase, 50-cycle current at 10,000 volts. This current is boosted to 60,000 volts by transformers on the premises. As a matter of fact, the transmission lines from all three plants are finally to be connected to transformers located outside but close to the Hourat station. These transformers will increase the potential to 150,000 volts and will constitute the point of departure of the high-tension line that is to feed the various substations along the railways.

The execution of this really pretentious project has been entrusted to the Société des Grandes Entreprises Méridionales, of Paris; and the details of the undertaking as herein described have been graciously furnished by Monsieur Taillardat, in charge of the work. The upper valley of Ossau, where the plants are in various stages of construction, is a thinly populated region and offers no accommodations for lodging the large force of men employed. It has, therefore, been necessary to build along the field of operations—which extends a distance of 15½ miles—camps for the workmen and houses for the resident engineers, office employees, and their families. These camps are quite up to date; and among other facilities there are first-aid stations, a hospital, clubs for the laborers and the engineers, and schools for the children. To insure a plentiful supply of foodstuffs and other commodities, coöperative stores and canteens have been established.

The railway terminal is about two-thirds of a mile away from the Hourat plant; and the main offices, stores, and a number of large warehouses have been erected close to rail head. These warehouses are connected with the main line, and are equipped with adequate machinery for unloading and handling heavy freight. In addition, there are a number of shops for doing repair work, etc.

The question of transportation, always a difficult problem in engineering tasks essayed

Showing exterior and interior of the Hourat hydro-electric plant. The inside view was taken during the erection of the five big electric generators.

Some Outstanding Aspects of this Great Hydro-Electric Project

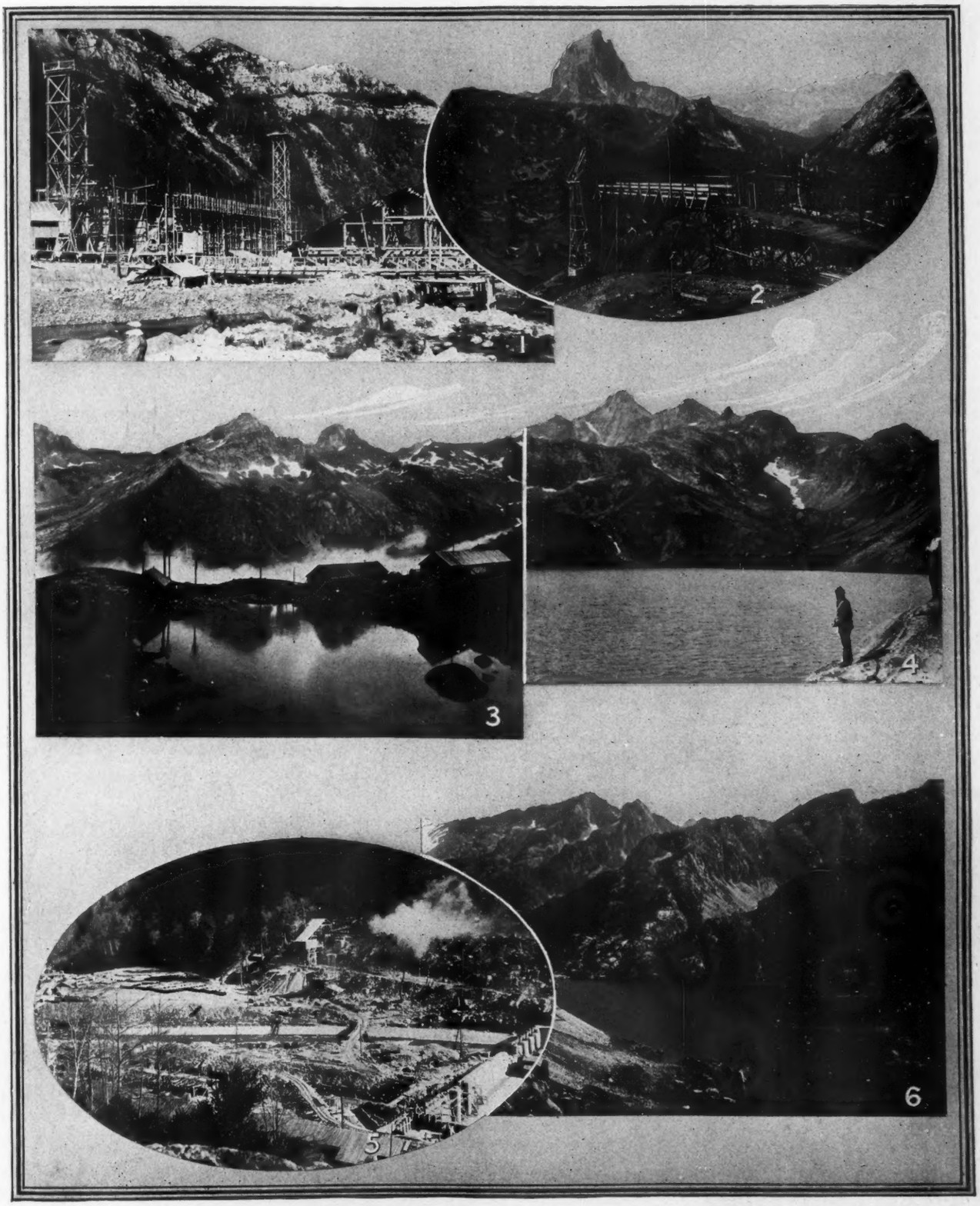
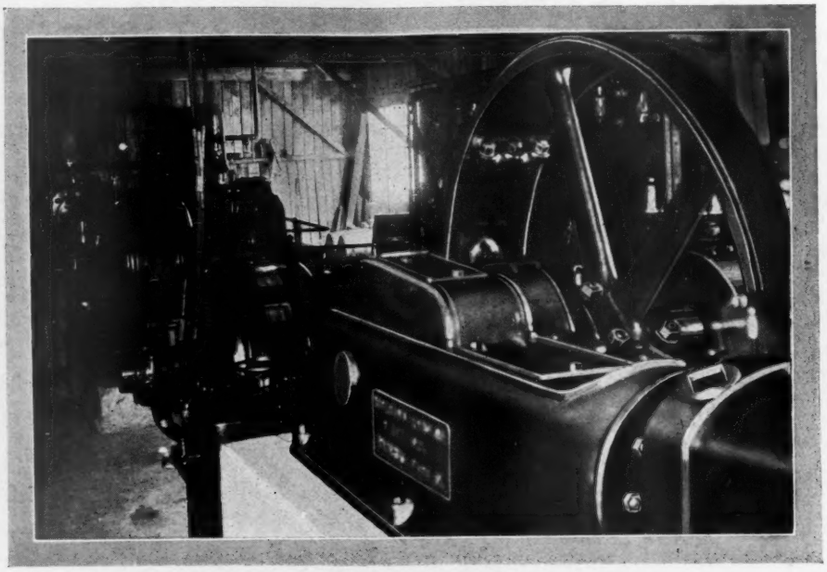


Fig. 1—Construction of the Miegebat plant.
Fig. 2—Cableway, situated about 6,500 feet above sea level, for transportation of materials.
Fig. 3—Compressor plant high up in the mountains.
Fig. 4—Lake Artouste, from which water will feed directly to one of the power houses.
Fig. 5—Quarry from which rock is obtained for construction purposes.
Fig. 6—Another view of beautiful Lake Artouste.

in mountainous regions, has, in part, been solved in the present case by the construction of a narrow-gage railway. This line traces its way over an existing road and parallels the river for a distance of almost 12½ miles. The tracks have a gage of 23.6 inches; and the gradient varies from 6 to 12 centimeters per meter, which makes hauling very difficult at times. At points, it has been found impossible to pull the trains by locomotives, and recourse has been had, instead, to a novel expedient: motor trucks running along on the road, because of their greater tractive power, have been used to draw cars up very steep grades.



One of the belt-driven, Imperial compressors, having a capacity of 600 cubic feet of free air per minute, used in advancing this great undertaking in the Pyrenees.

Materials are moved from the railway to the working sites by means of ten cables or inclined planes. Different systems are employed agreeably to the requirements of the service. For instance, cement and gravel for concrete are carried by continuous cableways, while heavier cables, capable of transporting 10-ton loads, lift, distribute, and place the different sections of the big penstocks. From the uppermost cable station, at an altitude of 6,560 feet above sea level, a narrow-gage railway runs for a distance of 6.2 miles and facilitates the haulage of building materials along the route of the upper tunnel to Lake Artouste.

A temporary, 500-H.P. hydro-electric plant was erected within three months to furnish necessary power during the early stages of the work. Later, a 60,000-volt transmission line, 24.8 miles long, was erected as rapidly as possible to feed a much larger block of power from the permanent plant at the lower end of the system. The 60,000-volt current thus obtained is delivered to a transformer that steps the current down to 15,000 volts, and this permits the sending of 3,000 H.P. to the scene of operations at the uppermost limits of the project. The energy is distributed by a line which follows the road for 12½ miles to the foot of the mountain slope and then runs up to Lake Artouste.

As might be expected, the driving of the long tunnels has necessitated a tremendous amount of drilling and blasting. In order to do this expeditiously, the several tunnels have been driven from numerous headings started at intervals of 1,312 feet. In rock of medium hardness the drilling has been done by means of BCR-430 "Jackhamers," and when contending with hard rock "Leyner" drills have been employed. The tunnels have been lined with concrete; and the cement gun has proved effective in this surfacing work. Monsieur Taillardat, speaking of these guns, says: "The mean efficiency of each apparatus has been 200 square meters (239.2 square yards) per day's work."

For driving the tunnels, for drilling in the quarries, for placing the concrete, for the operation of riveters, etc., large volumes of compressed air have been needed, the bulk of which has been supplied by Ingersoll-Rand, Type XB-2, belt-driven compressors.

The power plant and associate features at Miégebat will be finished in the spring of 1925, while the Artouste station and all its contributive works will not be completed until 1926. Therefore, the Hourat power house is the only one at present prepared to generate current.

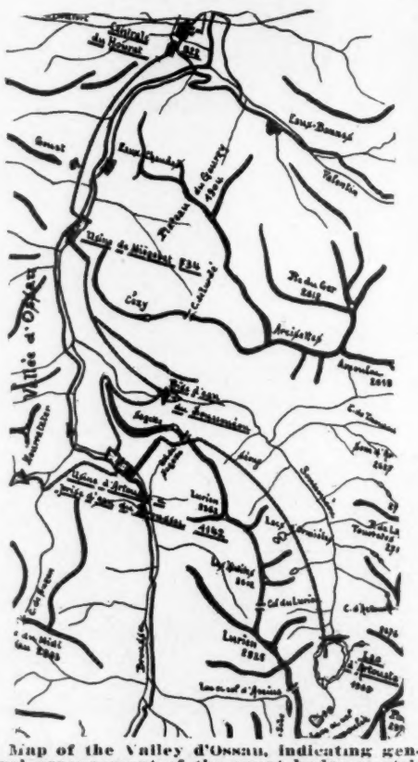
One of the great steel penstocks under construction for the hydro-electric plant known as "du Hourat." The descending water follows a very precipitous route.

With four times the population of the United States, China has less than 7,000 miles of railways, as against America's 265,000 miles.

Rainbow-trout eggs from Oregon waters—a gift from the United States to Czecho-Slovakia, are expected to be hatched in due time in that central European republic. The precious crate of eggs will be in the care of a special steward aboard a transatlantic liner; at Hamburg a courier will receive the package and carry it to Prague; and there the eggs will be placed in a hatchery. Eventually, the fish are to be used in stocking mountain streams whose natural conditions correspond to those of their native habitat.

SULPHUR GIVES STRENGTH

HERE is a curious thing, not easily to be fully accounted for. Tests made at the Bureau of Standards show that by simply soaking sandstone in melted sulphur, and then allowing the stone to cool, the crushing strength of the stone is increased from 200 to 300 per cent.—making it in this respect equal to granite. Sandstone is porous; and if immersed for a sufficient length of time in the molten sulphur the latter soaks all through it and hardens there as the stone is cooled.



Map of the Valley d'Ossau, indicating general arrangement of the great hydro-electric development in the Pyrenees. The dotted lines represent the tunnels that link up the various lower stations with the sources of operating water.

Oil-Electric Locomotive Comes to New York

ELEVENTH Avenue, New York City, was given a real surprise on Monday, June 9. A new smokeless and noiseless engine had replaced one of the puffing steam locomotives, which for years had been hauling and switching freight cars to and from the New York Central Railroad yards. Astonished citizens on their way to another week of toil could not understand what it was all about, but they realized that this engine did not smoke, grunt, or puff. Furthermore, it required no dangerous third rail or obstructive overhead trolley wires. It was a self-contained power plant.

But, despite their astonishment, did these people grasp that they were looking at a monument to American progress and engineering skill? Did they know that this type was what engineers had been working on for years—what they had been dreaming of and hoping for? Did they appreciate what it will mean to transportation—that very vital phase of American industry? Little did they think that future generations would envy them, just as we now envy the skeptics who saw Stevenson's first steam engine, or Fulton's *Clermont,* or the first electric train. For the passersby on Eleventh Avenue were privileged to see the first successful American oil-engine electric locomotive. They witnessed the first practical test on a railroad system of a self-contained electric locomotive using oil for fuel.

This novel oil-electric locomotive was built jointly by the General Electric Company and the Ingersoll-Rand Company; and was designed primarily for switching service—for which purpose it has been used to date. There is, however, no reason why units of this type cannot be adapted to the requirements of passenger service. Indeed, the inherent advantages for passenger haulage should be immediately apparent; and, unquestionably, railroad men and the general public will watch developments with keen interest.

The purpose of the experts of the two great manufacturing concerns has been to produce a locomotive which would combine the operative economies of the oil engine with the flexibility of control and the superior tractive powers of the electric locomotive. The gasoline-electric locomotive has been recognized as a step forward in the art for some while, but the cost of gasoline has, to a large extent, offset the mechanical gains. Therefore, the desire has been to devise a locomotive which might employ a prime mover that could utilize low-cost fuel oil—this engine serving to drive an electric generator which would furnish current for motors geared to the axles of the driving wheels. To the layman this probably sounds like a fairly simple proposition, but as a matter of fact much time and money have been expended in designing and in turning out a thoroughly satisfactory unit.

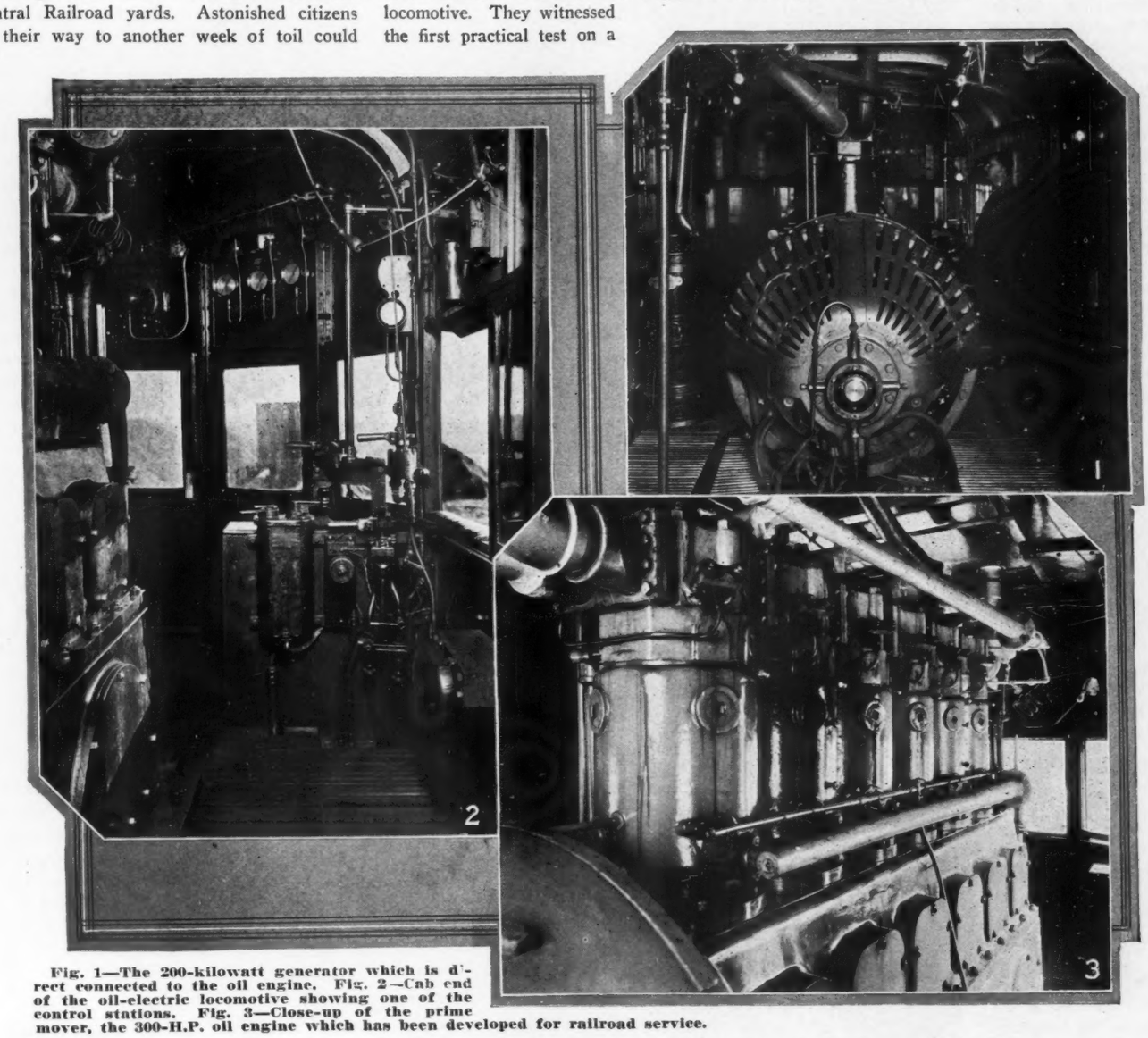
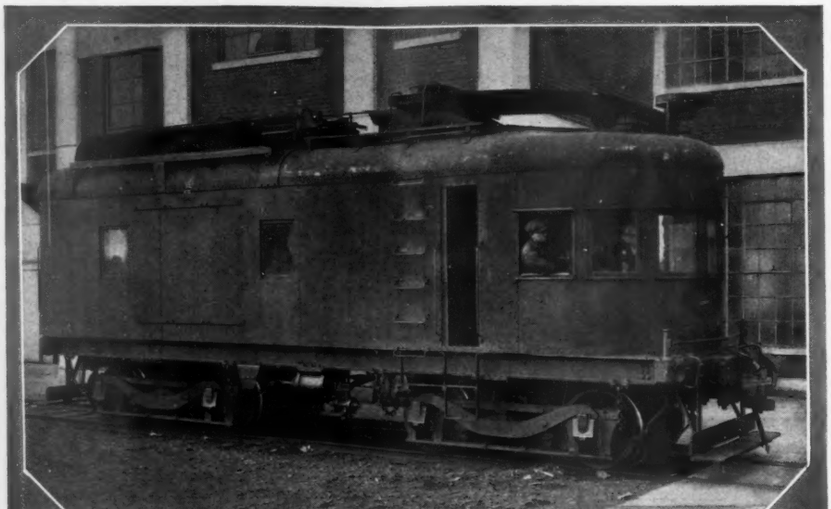


Fig. 1—The 200-kilowatt generator which is direct connected to the oil engine. Fig. 2—Cab end of the oil-electric locomotive showing one of the control stations. Fig. 3—Close-up of the prime mover, the 300-H.P. oil engine which has been developed for railroad service.

Before its transfer to Manhattan, the locomotive was employed for about four months in the yard of the Ingersoll-Rand Company's plant at Phillipsburg, N. J., where it was used daily in shifting loaded and empty freight cars. Its work was done well; and for ordinary switching service the fuel consumption per hour ranged between 20 and 26 cents worth of oil. In brief, the fuel bill was approximately one-third the cost of coal required by a steam locomotive of the type commonly doing work of this kind and burning soft coal. At the New York Central yards, where anthracite is necessarily used, the fuel-oil cost amounts to only about one-tenth that of coal. This is a point of considerable economic importance, because the Superpower Survey made by the Government in 1921 revealed that the shifting or yard locomotive was a spendthrift in the consumption of coal. This was shown to be due to the design as well as to the service conditions under which such engines operate.



Outwardly the oil-electric locomotive looks much like the familiar electric locomotive which draws energy from a trolley or a third rail.

In describing the test of June 9, the New York Times had, among other things, this to say:

"James McCue, for thirty-two years an employee of the New York Central and driver of a steam locomotive since 1905, learned to operate the new type of locomotive after ten minutes' instruction. 'It's the simplest locomotive in the world to operate,' he said. 'Cleaner and much better in every respect. Just what we have needed for such yards as this.'

"What pleased the engineer most was that the moment he opened the throttle he had the full power of the plant at his command. There were no slow, preliminary starts like those in getting an ordinary steam locomotive under way.

"The oil-burning locomotive is practically a one-man affair. A fireman is required under the rules of the Interstate Commerce Commission, but his sole duty apparently is to ring the bell. If an automatic bell is attached to the engine the fireman's duty will be nil.

"In the absence of smoke and in the fact that it is necessary to operate the engine only when the locomotive is in use, the new type of locomotive is much the same as an automobile."

Now for a few details.

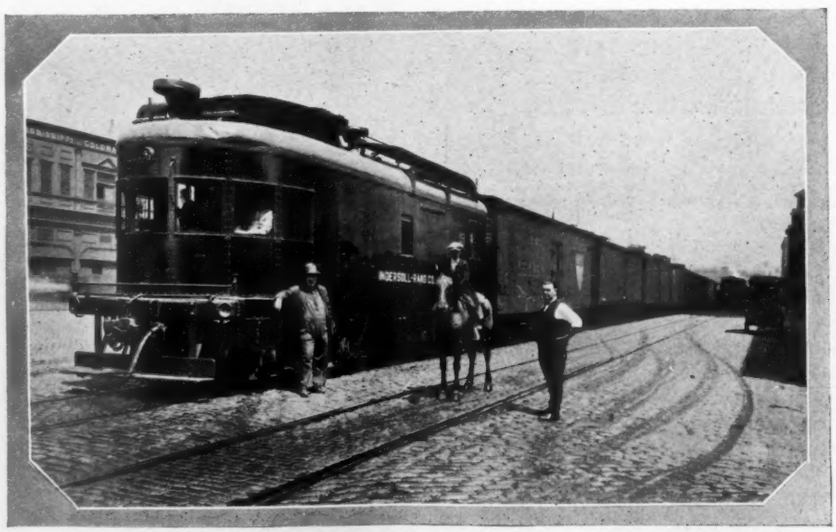
Outwardly, the oil-electric locomotive looks pretty much like some familiar types of electric locomotives, but inside the cab the unit is decidedly different. The power-plant equipment consists of a 300-H.P. Ingersoll-Rand oil engine which is directly connected to a 200-Kw. General Electric dynamo which generates the current for the operation of four 100-H.P. motors. The locomotive is mounted on four driving axles, and each axle is turned by one of these powerful motors. That is to say, the four motors are so geared to the four axles that all eight wheels become drivers. This arrangement insures a maximum of tractive effort for the power applied and for the weight of the unit. The weight of the locomotive is about 60 tons; and it is this weight which helps it to grip the rails and to exert a maximum pull. Enough fuel can be carried at a single filling to insure 48 hours of continuous switching service. A muffler, mounted on the roof of the cab, effectually reduces the noise of the engine exhaust.

The General Electric Company has been a pioneer in the development and the building of electric locomotives. The new oil-electric locomotive, therefore, has represented to a point a familiar problem except that it generates the necessary electric power by means of an oil-engine generator set, which is carried on board, and does not have to rely on a third rail or overhead conductors to deliver the needful motive energy. Accordingly, the equipment in its present form is made up of well-tried and proved elements which, in association, have already given ample evidence of a very marked advance in fuel economy over that possible with the steam locomotive.

The Ingersoll-Rand oil engine is a 6-cylinder unit designed to burn fuel oil, and it has the distinctive features of the well-known Ingersoll-Rand system of direct-injection of fuel oil. In this system two opposed spray nozzles are used to inject the oil into the combustion chamber of the engine. This system does not require the use of high-pressure air injection and, accordingly, makes possible a substantial saving in weight—improvements which contribute to mechanical efficiency and reliability while calling for a more simplified apparatus. The fuel is injected into the various cylinders through a distributor by means of a single plunger-type pump. The lubricating oil system is of the continuous filtration type, that is to say, the oil is returned from the crank case to a filter before it passes again into the lubricating system.

All parts of the cylinders, cylinder heads, and combustion chambers are water cooled; and the water supply is thermostatically controlled. The water from the water jackets passes on to a radiator which is located on the roof of the locomotive, where a thermostat maintains the water at an even temperature, regardless of weather conditions.

As already stated, the locomotive, when used for general switching service, consumes from 20 to 26 cents worth of fuel per hour. To be exact, the consumption is close to 0.40 pounds of fuel oil per brake horse-



People along Eleventh Avenue, in New York City, are still wondering how the oil-electric locomotive is able to pull out of the "hog pit" as many as eighteen heavily loaded freight cars.

power-hour. In an engine of the Ingersoll-Rand type, all the fuel injected into the engine is burned, and the exhaust is, therefore, clear.

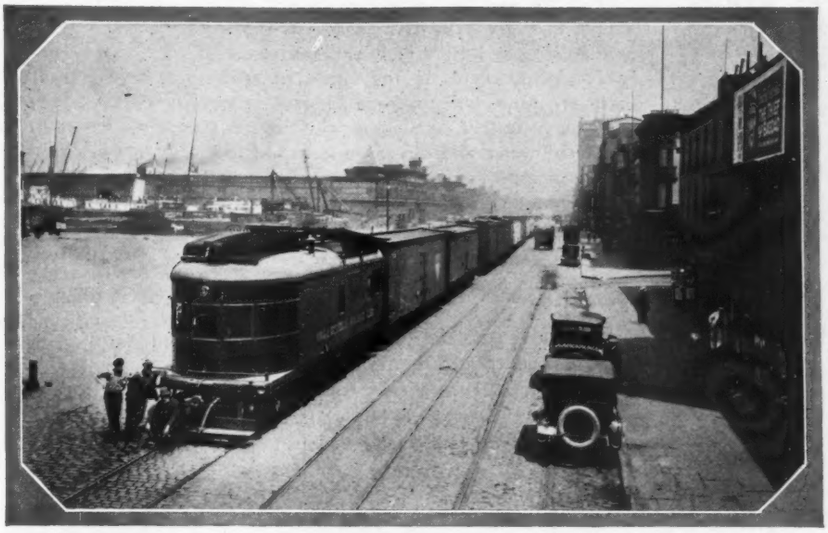
An unusual feature of the unit is the use of a direct-current generator for supplying energy to the motors without intervening resistance and yet in just the quantity desired by the operator. This is accomplished by means of a differential-series field on either the exciter or the generator. This arrangement reduces the generator voltage in accordance with the increase in the amount of current drawn by the motors. Therefore, the speed of the locomotive is automatically increased as the load is diminished —corresponding to the rise in impressed voltage. This control completely eliminates the possibility of overloading either the generator or the motors or of stalling the engine.

Contrary to the usual practice, the oil engine in this installation is not kept running at its maximum speed all the time and under the control of a governor. Its speed is hand controlled like that of a steam locomotive. The function of the electrical control is to transform the constant torque and the variable-speed characteristics of the oil engine into a variable tractive effort and such speed as may be required by the locomotive—achieving this without calling for any particular attention on the part of the operator. This form of control is more economical, and is likewise conducive to longer engine life. It is so arranged that the movement of the control lever opens the throttle and increases the engine speed from idling on up to maximum at the will of the engineer; and, at the same time, the exciter field is energized and this, in turn, energizes the generator field. Current for the main excitation of the exciter field is furnished by a storage battery, which also supplies control current and current for the lighting circuit. The locomotive is provided with two control stations.

People living within audible range of freight yards and sidings are fully alive to the annoyance caused both night and day by the noisy puffing of steam locomotives engaged in switching and shunting work. And even when these engines are at a standstill there is the loud and disquieting hiss of steam escaping from popping safety valves. The oil-electric locomotive is silent when idle because its engine is not then running; and when running, the engine's exhaust is so muffled that it cannot be heard except near by. Further, the exhaust is well-nigh invisible. This feature makes the locomotive peculiarly suited for service in cities or in other places where smoke is objectionable.

One has only to recall the millions of dollars spent annually in cleaning buildings exposed to the smoke from coal-burning engines to realize what a boon locomotives of the new type will prove in many communities. New Yorkers and others can appreciate what the oil-electric locomotive offers them in prospect as a relief from noise and smoke.

Because the new locomotive is a complete, self-contained unit—generating and utilizing its own electric current—it does not have to depend upon some more or less distant central station for "juice." Also, because of its dual power system, the locomotive can be placed upon the tracks of any steam line and does not need a third rail or overhead wires to feed it operative energy. Accordingly, the benefits of electric traction can be had without incurring the heavy expense of the transmission systems common to existing electrified railroads.



Apart from its other advantages over the steam locomotives heretofore employed on Eleventh Avenue for shifting service, the oil-electric locomotive is notably valuable because of the ease with which it can be started and then stopped within a few feet.

From left to right, James McCue, the enthusiastic engineer of the oil-electric locomotive, and Tom Walsh, freight conductor.

PRODUCTIVE ASPHALT WELL IN NORTH AMERICA

WHAT is said to be the only asphalt well in North America has been discovered and developed within the past two years in Murray County, Oklahoma; and *Petroleum World* has recently given out some interesting particulars on this subject.

The asphalt-producing sand was drilled into down to a depth of 1,232 feet; and the asphalt that flowed up and over the top of the casing looked like thick, black tar. Earthen tanks were at once constructed; and the well was put on the pump, as is the practice with oil, but no working piston or valves could carry the viscous liquid through.

A platform was then erected about 20 feet up in the rig, and a chute was run from a dump on this platform to storage tanks. A slow-moving bailer, lifting about 50 gallons at each stroke, now delivers about 65 barrels a day. Each day's bailing lowers the well about 250 feet, but by the next morning the flow is up to the normal level again, which is about 20 feet from the top of the hole. The asphalt so obtained is sold at $18.50 per barrel of 55 gallons.

The chairman of the board of a flourishing bituminous coal company recently visited several of his mines and found that the most urgent business on hand was to make provision for additional garage space for motor cars belonging to the miners. At one of the mines, $32,000 was expended for this purpose; and it is said that miners refuse to work for a company that hasn't a garage with ample parking space. We pay our share of the expense when we buy our winter's supply of coal.

SAN FRANCISCO HAS MODEL AQUARIUM

By CHARLES W. GEIGER

THERE has recently been completed in Golden Gate Park, San Francisco, Cal., a thoroughly up-to-date aquarium, which is claimed to be the finest institution of its kind in the world. The so-called Steinhart Aquarium, built at a cost of $300,000 provided in the Steinhart bequest, is in charge of Dr. Barton Warren Evermann, Director of the Museum of the California Academy of Sciences, who, together with the architect, traveled far and wide before structural operations were undertaken for the purpose of combining in one building all the best ideas and practices in aquarium architecture.

There are 57 large exhibition tanks within the walls of the aquarium, and to each of these pipes convey compressed air wherewith to aerate the water in case the pumps break down that usually supply filtered water to the tanks or the tanks become overcrowded with fish.

For the purpose of providing water at the right temperature for sea life from the artics and the tropics, there has been installed a refrigerating as well as a heating plant. The latter furnishes salt water at a temperature of 86°F., while the refrigerating system keeps the water at a temperature of 50°F., thus taking care of the needs of various aquatic creatures.

By means of a group of automatically controlled pumps, a filtering plant, and large supply tanks, each exhibition tank is continually being fed filtered water. There are four of these supply tanks, each with a capacity of 20,000 gallons, so located above the exhibition tanks that water may flow into the latter by gravity. One supply tank is kept filled with fresh water, one with salt water, one with hot salt water, and one with cold salt water—all the water, whether fresh or salty, hot or cold, being filtered. Each supply tank has its own pumps.

From the overhead reservoirs, water is delivered to every exhibition tank at a rate of two gallons per hour. The overflow from the fish tanks gravitates to the filters, of which there are four—one for each kind of water. The pumps, in turn, again deal with the freshly filtered water and discharge it to the four supply tanks, thus maintaining a continuous circulation.

Besides the 50-odd tanks, several ponds for alligators, snakes, and turtles have been built into the main floor of the Steinhart Aquarium; and, because of favorable climatic conditions, three outdoor pools for seals and other mammals offer added attractions. Another feature of interest are the hatcheries, which will give the public a chance to see how the State Fish and Game Commission conducts its fish propagating and planting operations.

Top—Main entrance of the Steinhart Aquarium in Golden Gate Park, San Francisco, Cal. Left—Pumps and filters used in maintaining a circulation of clean water in the aquarium tanks. Compressed air is employed to cleanse the filters. Right—Rear view of exhibition tanks in which the water is revitalized continually by submerged jets of compressed air.

DISASTROUS EXPLOSION BY USE OF WRONG DRUG

A DISASTROUS explosion recently occurred in a department store at Norwalk, Ohio, wrecking the store and causing the loss of several lives. The earliest published account attributed the explosion to ammonia; but later investigations clearly showed that the explosion was the result of an error in using calcium carbide in place of calcium chloride for strengthening the brine solution in the tank of the refrigerating plant.

The men in charge had used 100 pounds of granulated calcium carbide and had added water to it. The addition of the water immediately formed an inflammable gas, and either the workmen were smoking or a naked flame was in close proximity to the tank.

MINING COAL AND IRON UNDER THE SEA

INTERESTING data concerning the mining of coal and iron under the sea in Nova Scotia and Newfoundland have recently been given out by the British Empire Steel Corporation, Ltd., of Montreal. At Sydney, Nova Scotia, the coal seams extend inland for a comparatively short distance; but the limit of their reach beneath the ocean is not yet known. Mines are already being run up to 2¼ miles in length in the latter direction; and there is nothing to indicate how far out under the water the workings may be carried.

For profitable operation, the equipment required is very expensive: one of the new collieries now under construction will cost about $2,500,000. But it is expected that this expenditure will make available 1,000,000,000 tons of coal; and it is estimated that the working of the deposits will extend over 120 years.

The same corporation which is carrying on this coal development is also conducting costly operations in mining iron ore under the sea at Wabana, Newfoundland. The conditions there have no geological counterpart anywhere in the world. The iron ore is found in seams as uniform in thickness and as regular in inclination as a normal coal deposit. The extreme end of the main tunnel, from which ore is now being mined, is over two miles out from the shore; and at that point the workings are in an ore seam varying in thickness from 15 to 30 feet. Here, too, no one knows how far under the sea these deposits extend; but it is believed that the distance is very great and that for many years to come the ore can be profitably worked.

Making Ice at a Fuel Cost of Only Twenty-four Cents a Ton

Oil-Engine Drive Renders Substantial Economies Practicable in the Plant of a Three-Sided Business

By ROBERT G. SKERRETT

PITMAN is an enterprising town with a winter population of 5,000 persons. This number, thanks to a healthful and agreeable environment, is swelled to 10,000 in the summer season. But Pitman's claim to wider prominence is due primarily to its location in the heart of a thriving fruit-growing and truck-gardening section of New Jersey and because populous Philadelphia, but seventeen miles away to the north, offers a ready market for most of this produce.

It is not overstating the case to say that a very considerable part of the success of neighboring farmers is directly traceable to refrigerating facilities which have developed latterly for the holding of perishable foodstuffs until the market offered chances for their profitable disposal. This aspect of the subject is mentioned because it weighed heavily in bringing about the incorporation of the Riley Milk, Ice & Cold Storage Company.

Milk, ice, and cold storage are everyday necessities, measured by the standards of modern life. Manifestly, a business in any community that deals with all three of these essentials must be of outstanding importance The activities of the company in question are no exception to this rule. However, the scale upon which these activities are carried out and the character of the service rendered are such as to affect intimately a number of other communities embracing a total patronage of fully 20,000 persons.

Twenty years ago, Mr. Riley, a lad of but nineteen, started in the milk business. His outfit consisted of a horse and wagon and enough bottles to handle 80 quarts of milk a day. Being mindful of his customers and zealous in his efforts to please, young Riley's milk business grew. As might be expected, the preservation of his commodity obliged him to buy ice; and seven years ago he added the sale and distribution of ice to his communal service. By that time, Riley's Dairies was one of the thriving features of the industrial life of Pitman. The only drawback to this departure lay in the fact that the ice so handled came from a neighboring town and was largely a by-product of a cold-storage plant for fruit. That is to say, when the refrigerating demand was at its highest—possibly in the middle of summer—there was no ice to be had from this source. Not only that, the ice was made from surface water containing iron, and occasionally this colored the ice various shades of red and yellow and impaired its marketability.

For the accommodation of his customers and to safeguard the business which he had built up among people that had grown to depend upon him, it became necessary more than a year ago to create a self-contained establishment which, besides amplifying the dairy feature, would be able to produce quite 25 tons of ice every 24 hours and have a cold-storage capacity sufficient to take care of 75,000 hampers of fruit at a time. A hamper holds about a bushel. The construction of the plant was begun in March of 1923; and building operations were pushed so energetically that the establishment was ready to start running on July 14, following.

The company sells its ice wholesale; and, in addition to providing for the citizens of Pitman, it supplies ice to Glassboro, Woodbury, Wenonah, Sewell, Mantua, and Blackwood. In the wintertime about 20 tons of ice are pulled daily; and in the height of warm weather as many as 218 cakes have been pulled in the course of 24 hours. The cakes average 315 pounds apiece—7 cakes being allowed for a ton, on the platform. This provides a liberal allowance for melting and waste in cutting, and insures the retailer a margin which will enable him to give his customers all that they pay for.

SAVING his business and giving his customers better service, describes briefly what C. J. Riley has achieved since he laid the foundation in March, 1923, of the undertaking which now bears his name.

The success that has followed since is due in no small part to the wise choice of economical prime movers and to the adoption of ammonia compressors of a notably efficient type. Together, these essential equipments have enabled the Riley Milk, Ice & Cold Storage Company to produce power and refrigeration at a remarkably low unit cost. Further, the plant gives not only better service than the locality enjoyed before but it contributes to the welfare, the comfort, and the convenience of a much-enlarged zone.

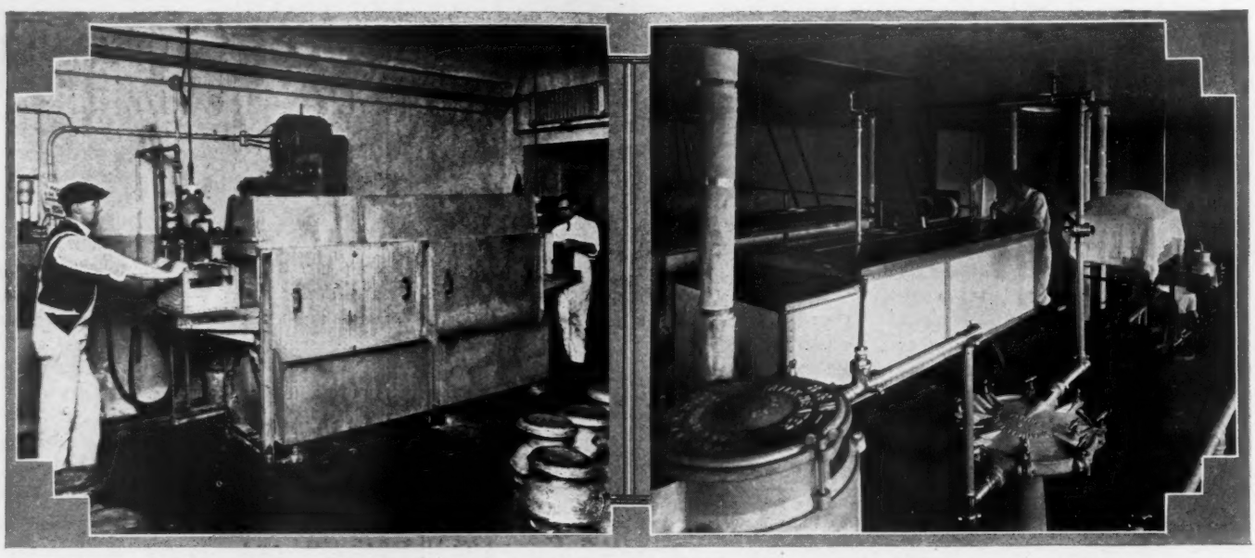
What has been done by this up-to-date establishment at Pitman, N. J., is the best evidence of what can be done elsewhere in meeting similar market conditions. In short, the accompanying story is one that should interest a wide circle of readers having allied problems to solve and who, at the same time, are equally bent upon getting and giving the most for the money involved.

The water used in the plant comes from an Artesian well 246 feet deep; and from it are pumped 150 gallons a minute. The temperature of this water is 52°F., and it is virtually at this temperature when it reaches the ice cans after passing through a sand, gravel, and charcoal filter. Needless to say, the filtered water is pure and free from anything that would mar the clearness and the palatableness of the ice. From this same well is drawn the water which goes to the Vogt ammonia condenser and thence into the circulating system of the oil engines.

In order that the reader shall not be confused by the threefold purposes of the plant, let us take up the dairy end of the establishment first, because this is the oldest of the activities with which the president of the company has been associated. The dairy department is absolutely up to date and equipped with pasteurizing and bottling facilities capable of handling 12,000 quarts a day. It may be interesting to mention that the milk from this department is distributed to no fewer than twelve towns. All told, six grades of milk are dealt with. These are classed as follows: pasteurized; tuberculin-tested Grade A; regular tuberculin-tested; regular raw; and Walker-Gordon certified raw, and certified pasteurized.

Immediately after its arrival at the platform, the milk is poured into a receiving tank from which it is pumped to a pre-warmer or Burrell heater, in which the temperature of the milk is raised to 80°F. in order to facilitate filtering. From the heater the milk goes to an International milk filter; and it is surprising how much undesirable material this apparatus will remove from supposedly clean milk. After leaving the filter, the milk is piped to two pasteurizers where it is heated to a temperature of 142°F. and held at that point for 30 minutes. Upon completion of the pasteurizing process, the milk is allowed to descend over a series of refrigerated coils—encased to protect the milk from the atmosphere, and this brine cooler serves to chill the milk to a temperature of 38°F. in the brief span of five seconds.

As most of us know, the purpose of pasteurization is to kill the bacterial life present in the milk by recourse to sufficiently high temperature. The pasteurizers are porcelain-lined, covered tanks equipped with horizontal rotating coils through which circulates hot water heated by steam. The milk is played upon the coils and is thus brought up to the prescribed temperature, which destroys the harmful or objectionable bacteria. If steam instead of hot water were passed through the coils, the piping would become too hot and scald or cook the milk—which is not desired principally because it would affect the taste of the milk. It is equally important that the milk shall be chilled quickly after pasteurizing to a point below that at which bacteria can be propagated

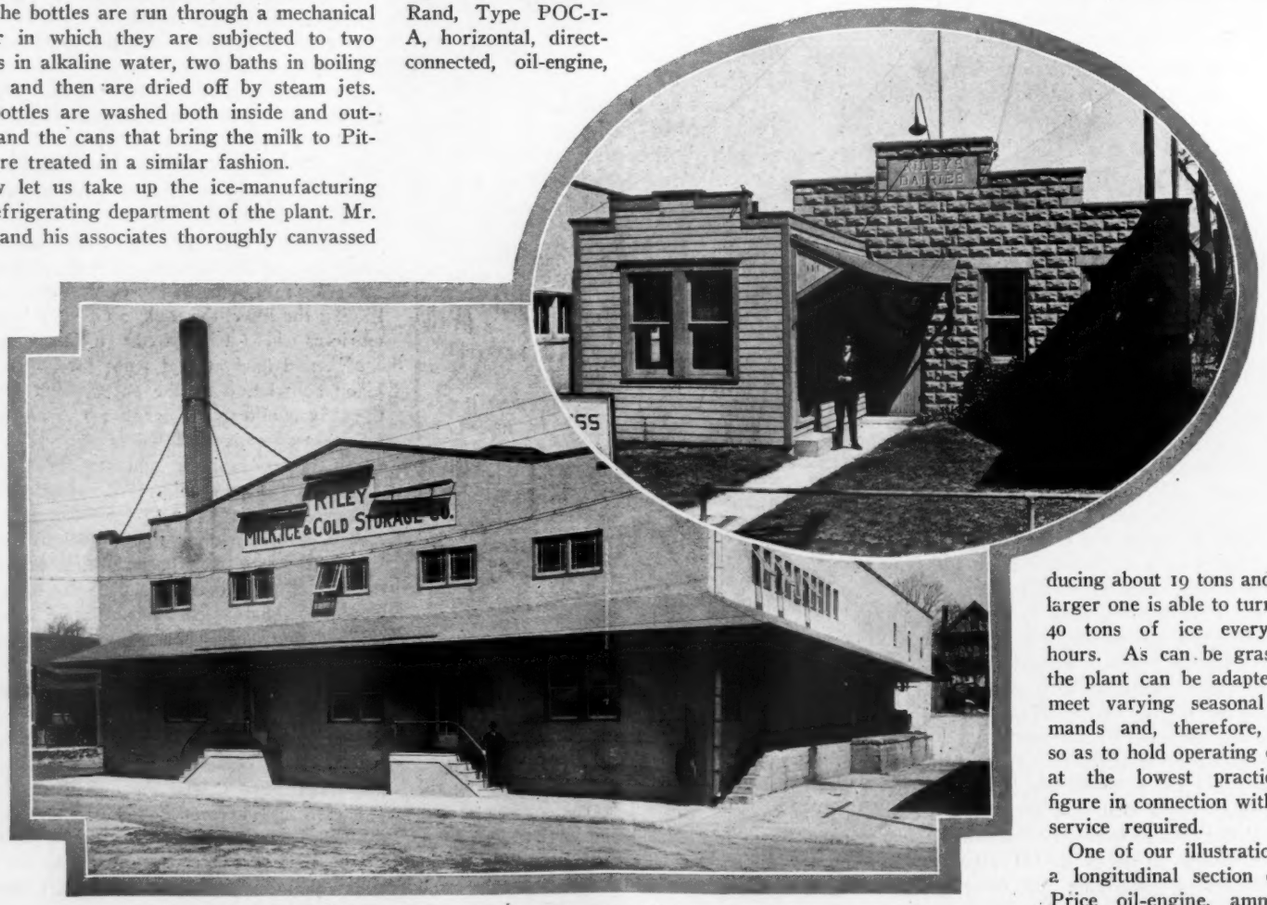


Left—Washing machine which thoroughly cleanses and sterilizes all bottles and cans used by the company. Right—Pasteurizing department of the plant. After passing through the heater, at the left of the picture, the milk is run through the associated filter and then on to one or the other of the two rectangular pasteurizers.

anew. Hence the function of the brine cooler or refrigerating coils.

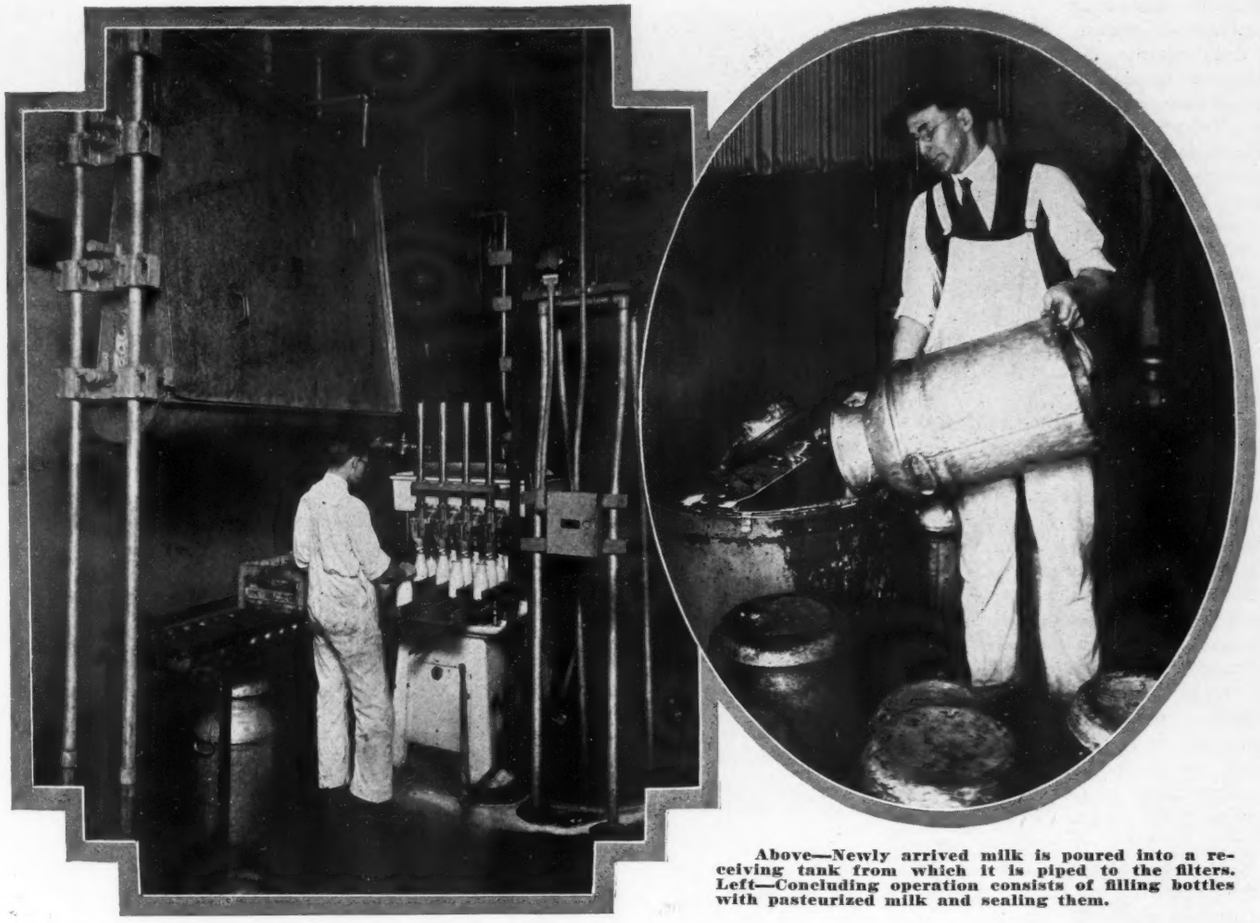
As soon as the milk has been cooled to 38°F. it is pumped to the bottling machine which both fills and seals the glass containers. If not immediately dispatched, the bottled milk is placed in cold storage and held there the comparatively short time between bottling and distribution. In order to insure absolute cleanliness, the bottles are run through a mechanical washer in which they are subjected to two washes in alkaline water, two baths in boiling water, and then are dried off by steam jets. The bottles are washed both inside and outside; and the cans that bring the milk to Pitman are treated in a similar fashion.

Now let us take up the ice-manufacturing and refrigerating department of the plant. Mr. Riley and his associates thoroughly canvassed the market before deciding upon their choice of prime movers and ammonia compressors. Realizing that their outlay would necessarily be a heavy one, they were naturally desirous of obtaining the best that engineering skill could offer. Operative economy and general efficiency were points which they kept continually before them. In the end, they elected to buy two Ingersoll-Rand, Type POC-1-A, horizontal, direct-connected, oil-engine, ammonia units—one of 100 H.P., with a refrigerating capacity of 65 tons, and the other, a stand-by unit of 50-H.P., having a refrigerating capacity of 33 tons per 24 hours. The machines usually operate upon a suction pressure of 20 pounds and a discharge pressure of 155 pounds. When engaged only in manufacturing ice, the smaller unit is capable of producing about 19 tons and the larger one is able to turn out 40 tons of ice every 24 hours. As can be grasped, the plant can be adapted to meet varying seasonal demands and, therefore, run so as to hold operating costs at the lowest practicable figure in connection with the service required.



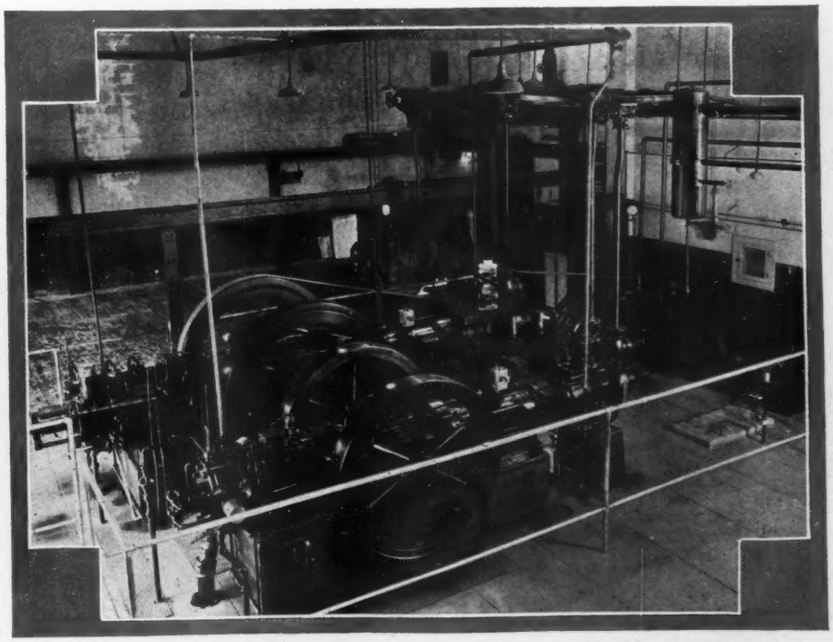
Oval—Plant vacated by Mr. Riley when the new establishment of the Riley Milk, Ice & Cold Storage Company was ready for service last summer.

One of our illustrations—a longitudinal section of a Price oil-engine, ammonia compressor—shows some of



Above—Newly arrived milk is poured into a receiving tank from which it is piped to the filters. Left—Concluding operation consists of filling bottles with pasteurized milk and sealing them.

the outstanding features of this admirable type, which is so simple in its get-up and so reliable in its performance that it has uniformly given satisfaction and won the commendation of the men immediately in charge. These engines are of the single-cylinder, single-acting, direct-injection type, operating on a 4-stroke cycle. The fuel is injected into the combustion chamber from two oppositely placed spray nozzles; and the force of the opposing sprays suffices to bring about complete atomization of the fuel oil without the use of a compressed air impulse. The oil is delivered under pressure to the nozzles by an injection pump. This arrangement dispenses with a number of troublesome features which are commonly associated with compressed air atomizing of fuel oil. The heat of compression alone is high enough to induce ignition; and this compression will ignite the fuel even when the engine is cold. In other words, it is not necessary to have recourse to hot bulbs, hot plates, electric coils, or any other kindred and more or less vexatious system of ignition. The practical engineer knows full well what this represents in the way of a long step forward in the development of the oil engine.

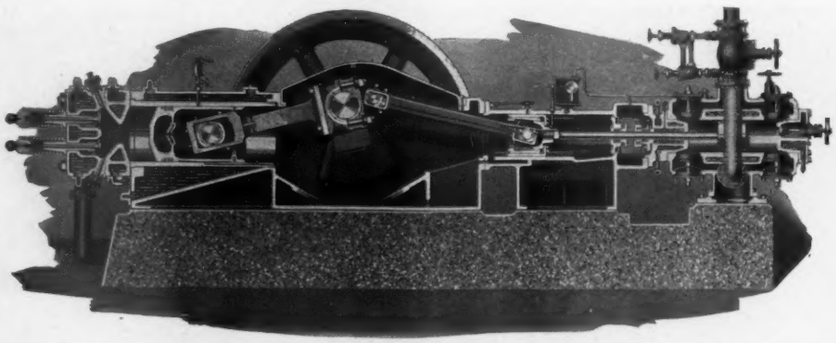


General view of power plant and ice tank. Small belt-driven compressor at extreme right provides agitating air for the ice cans.

The ammonia compressor cylinder is horizontal and directly opposite the oil engine cylinder. The cap of the engine crank-pin bearing receives the compressor crank pin, thus transmitting power through the compressor connecting rod and crosshead to the ammonia cylinder piston rod and piston. This construction obviates the use of power-consuming bearings—such as are employed when a side crank arrangement is adopted, and higher mechanical efficiency is thereby obtained.

The double-acting, single-stage, ammonia cylinder is of cast iron; and the barrel and cylinder heads are completely water jacketed, in this way reducing the heat of compression and insuring the efficient lubrication of the cylinder. Both intake and discharge ports are equipped with Ingersoll-Rand plate valves, and these valves are placed in the cylinder tangent to the bore so as to provide a minimum clearance. The discharge valves are lo-

cated at the bottom of the cylinder—a disposition that prevents the trapping of liquid ammonia in the cylinder barrel. The plate valves operate automatically and are entirely independent of any moving valve gear. They have large, free port and lift openings; and the tension of the valve springs is adjusted so as to offer the least possible resistance to the intake or the discharge of ammonia. In short, the valves are of light weight and low lift; and their action is quick and positive, while their tightness or sealing capacity increases with use. This helps to explain how high compression efficiency is realized.



Longitudinal section of an Ingersoll-Rand POC-1-A, horizontal, direct-connected, oil-engine, ammonia unit.

A hand-operated by-pass valve permits unloading the compressor during starting periods. By opening this valve the ammonia gas is completely by-passed from the discharge to the suction passage, and this leaves the oil engine free to reach full speed before the compressor load is thrown on.

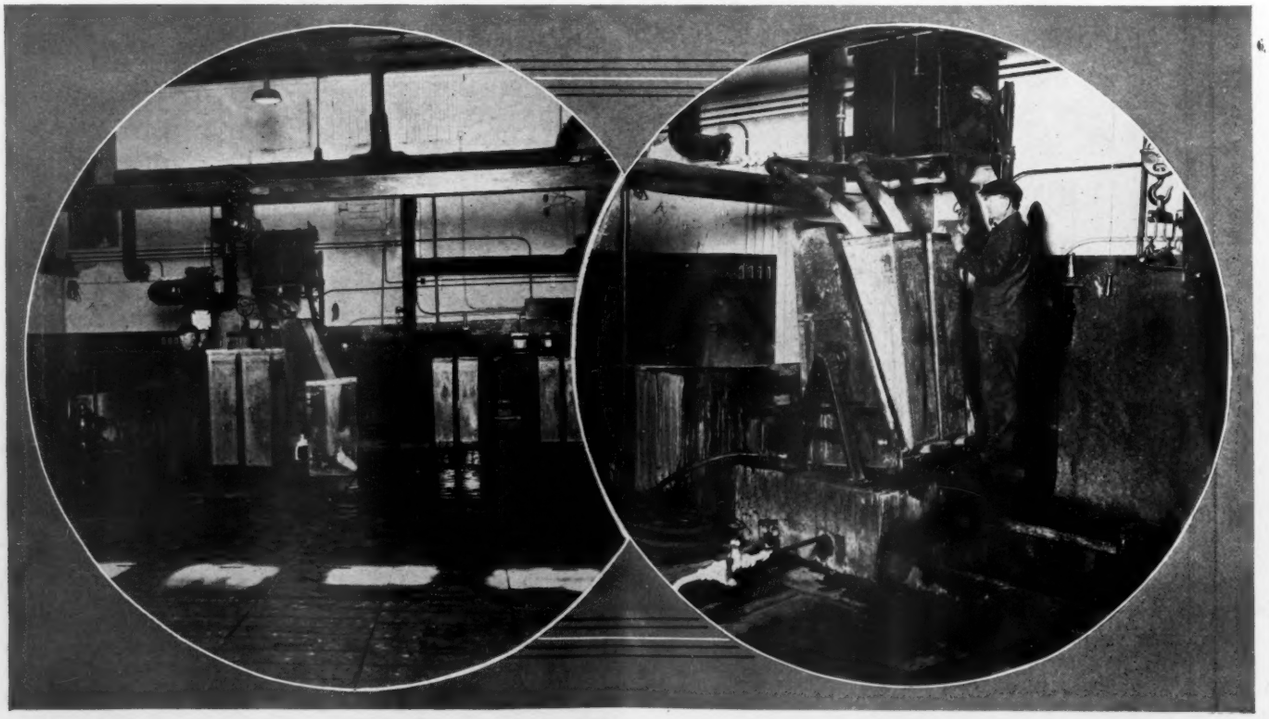
Inasmuch as operating conditions in any plant may vary and the range of working pressures also alter, the prime mover might be overloaded unless means be available for changing the capacity of the compressor cylinder to suit the differing demands. Accordingly, ammonia compressors of this up-to-date make are equipped with clearance-control features which render the machine extremely adaptable. To be specific, the ammonia cylinder back-head contains, as an integral part of the casting, a clearance pocket which can be opened by a hand-controlled clearance valve. The function of this device is so important that a brief description of it is warranted here.

The operation of the clearance pocket is as follows: With the compressor operating at partial capacity a portion of the ammonia gas is compressed into the added clearance space instead of passing through the discharge valves. On the return stroke of the double-acting piston this gas expands, giving up its stored energy to the piston. The compressor inlet valves remain closed until the cylinder pressure equals the intake pressure, at which time the inlet valves open automatically and ammonia gas is sucked into the cylinder for the remainder of the return stroke. Thus the inlet capacity of the compressor is reduced without reducing the intake pressure or the efficiency. The form of the pocket allows any accumulated liquid ammonia to drain into the cylinder where it will be discharged from the compressor through the discharge valves located at the bottom of the cylinder bore.

In addition to making it possible to operate the ammonia compressor under varying pressure conditions, the use of the clearance pocket permits the compressor to be run under ordinary pressure conditions at partial capacity. It also allows the engine to assume its load in gradual steps when starting. So much for the oil-engine ammonia compressor units. Now let us return to the actual manufacture of ice.

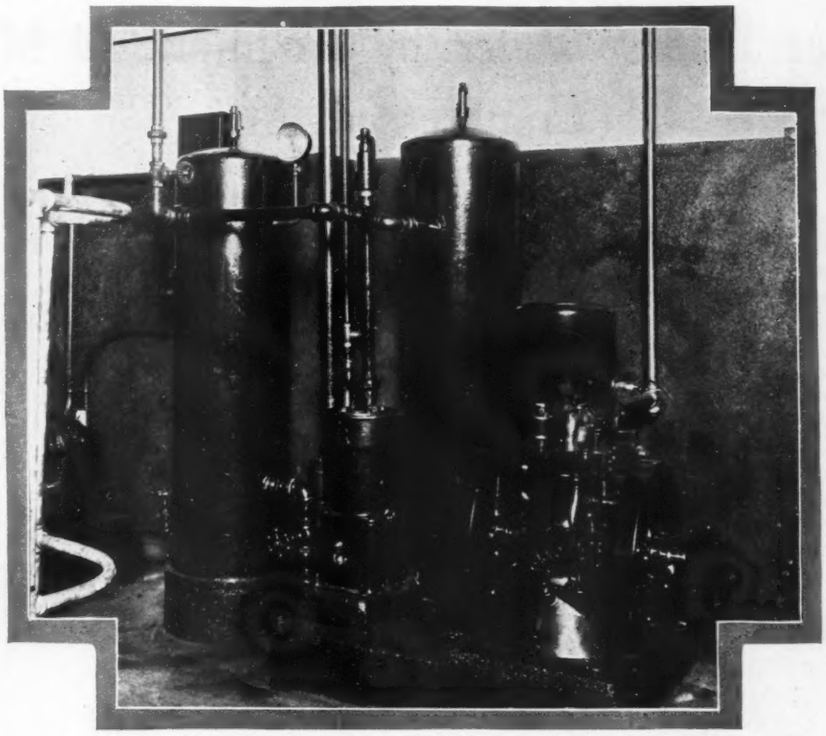
Temperature of water entering condensers at degrees Fahrenheit	52
Temperature of water leaving condensers, at degrees Fahrenheit	60
Temperature of water entering ice cans, at degrees Fahrenheit	52
Average suction pressure, pounds per square inch gage	15–20
Average discharge pressure, pounds per square inch gage	145–155
Average tons of ice pulled per day	25
Average tons of refrigeration per day for cold storage	10
Average total tons of refrigeration per day	46.8
Fuel oil per day, gallons	88
Lubricating oil per day, gallons	1.5
Daily cost of fuel oil, at six cents per gallon	$5.28
Daily cost of lubricating oil, at fifty cents per gallon	$0.75
Total cost of oil (fuel and lubricating) per day	$6.03
Total cost of oil (fuel and lubricating) per ton of ice	$0.24
Average kilowatt-hours per ton of ice in an electrically driven plant	38.5
Cost of power per ton of ice at three cents per kilowatt-hour	$1.155

The ice tank contains 334 so-called 300-pound cans; and the surrounding brine is cooled by immersed coils chilled by the direct



Left—Can-handling hoist in ice tank room. Right—Can-filling equipment, dipping tank, and ice dump.

expansion of gaseous ammonia. The brine is circulated within the tank by two electrically driven propellers. Being a raw-water plant, the water in the cans is agitated by compressed air; and a pressure of 25 pounds is used in the agitating system because of the superior results obtained and the safeguard this pressure affords against the clogging of the jets at certain critical stages in the freezing operation. Air for this purpose is furnished by a 7x5-inch, belt-driven, ER compressor. The air is first dehydrated and cooled by brine; and is delivered at a temperature of 33°F. to the agitating equipment.



Direct-connected, vertical compressor which supplies starting air for the oil-engine, ammonia compressors.

In addition to providing refrigeration, the 100-H.P. unit drives by belt from one of its flywheels a 37½-KVA., General Electric generator with a direct-connected exciter. This dynamo supplies current for lighting the plant and for the operation of a number of auxiliaries. Electricity so made in the plant costs three-quarters of a cent a kilowatt delivered at the switchboard. Air for starting the two prime movers is obtained from a small vertical compressor directly connected to a Novo engine. As can be seen, the establishment is a self-contained one; and according to Mr. Riley, his fuel cost per ton of ice manufactured is less than 24 cents! We cannot refrain from tabulating some of the essential performance data and showing how these figures compare with those of a plant using electric drive instead of oil engines.

At the present time there is storage space in the plant for 28 tons of ice or for the holding of 75,000 hampers of fruit —the latter requiring the equivalent of 10 tons of refrigeration daily. This part of the business has proved unexpectedly encouraging; and there will be finished during the present year an annex which will be ample enough to accommodate 200,000 hampers. This expansion of the available cold-storage facilities will take care of the peak periods of fruit and vegetable production and be a boon to the neighboring farmers. Speaking of the two machines at present in the plant, Mr. Riley has said: "The ice plant started the very day we opened and before the engines had been given half a chance to work into the usual sweet running condition. They have performed splendidly ever since, and we are absolutely satisfied with them." The entire establishment represents an expenditure of $172,000.

In conclusion, it is fitting that some mention be made of the reciprocal benefits enjoyed by the outlying farmers and the enterprising management of the Riley Milk, Ice & Cold Storage Company. In the past, the farmers and fruit growers have hesitated to make the most of the natural advantages of the region because on several occasions abundant crops have entailed sacrifice inasmuch as they could not be promptly marketed at a good price. Gradually, the agriculturists situated within a zone having an average radius of seven miles from Pitman have come to realize by practical experience what cold storage can do for them. They have learned that they could turn a possible loss into a profit by thus holding their produce sometimes for only a few days. One instance will answer by way of illustration: A farmer found himself unable to get more than 50 cents a barrel for cabbages, so he sent a goodly number of barrels of them to Pitman for keeping —paying a charge of 60 cents a package for storage. A little later he was able to sell his cabbages for $2.50 a barrel, thus netting a gain of $1.40 a barrel by being able to wait for a favorable market.

The prime movers in the refrigerating plant are two Ingersoll-Rand, oil-engine, ammonia compressors. The 50-H.P. unit is at the left and the 100-H.P. unit at the right.

PROLONGING THE LIFE OF AN OLD BRIDGE

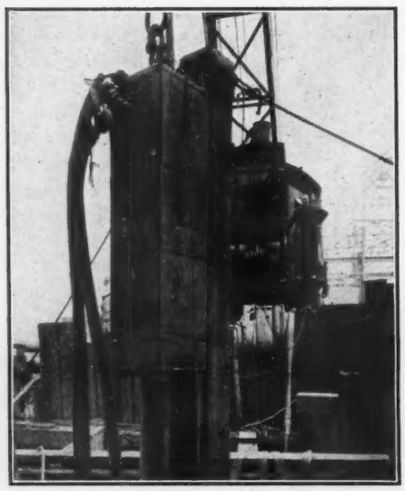
AN old sandstone bridge, 40 feet wide and 90 feet long, built in 1818 over Little Wheeling Creek, Elm Grove, W. Va., has been given a new lease on life by covering its exposed surfaces with a coating of gunite by the aid of a cement gun. While the stonework of the bridge was in good condition, the action of the weather had caused the lime mortar at the joints to disintegrate. A contract was therefore let for the preservation of the structure.

All loose stones were removed, and the crumbled mortar at the joints was cleaned out both by air and by water blasts. With these preparations done, the sides and the parapet walls were covered with gunite an inch thick while the arches received a coating of two inches.

Driving Piles Under Water by an Improved Method Using Compressed Air

By R. F. MUNDORFF

A NEW method of submarine pile driving has recently been developed which is a radical departure from the older practice. The hammer employed is so arranged that compressed air at low pressure is supplied to a bottom cylinder by means of an air hose connected at the hand-hole cover. Either steam or compressed air may be used for motive power; and the exhaust from the pile hammer is carried to the surface through a hose. The



Close-up of the pneumatic pile driver which is so designed that the hammer, when driving piles under water, can operate within an air chamber instead of against incompressible water.

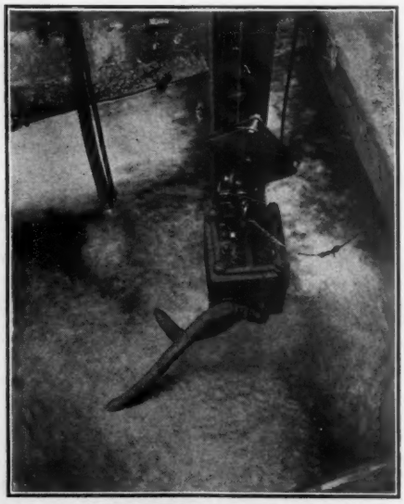
bottom cylinder, into which the compressed air is introduced, is not intended to be watertight. It is supposed to function on the principle of the diving bell—that is, the water is kept out of it by the counter pressure of the compressed air.

This method was developed in preparing the groundwork for the large power plant being built for the Brooklyn Edison Company in New York City. In laying the foundation for the structure, it was found necessary to drive piles under water for from 30 to 40 feet deep in 11 cofferdams without unwatering the cofferdams. A total of 3,000 piles were driven to a penetration of from 15 to 25 feet and spaced on about 2-foot centers.

A hammer, weighing approximately 6,600 pounds, was mounted on a sliding carriage which, in turn, engaged a rail track attached to a timber spud about 55 feet long. A stop was riveted to the top of the channel carriage to prevent the hammer from being pulled out of its guides; another stop was placed at the upper end of the spud to limit the upward movement of the carriage; and at the bottom of the carriage there was provided a toe piece, consisting of a pair of steel straps with drill holes large enough to receive fairly big spikes. The function of the toe piece—through which the spikes are driven, one from each side, into the wooden pile—is to hold the lower end of the pile in place before driving and to guide it in its descent.

The piles, sawed into suitable lengths and shoed with metal points, are "snaked" or drawn into proper position under the hammer. The top of the pile is then fitted beneath the bell-bottom anvil block of the hammer; the foot of the pile is swung into the U-shaped opening formed by the sides of the toe piece; and the two spikes are driven partway into the pile to hold its point in line. Next, the spud is accurately spotted by the derrick boom, which is brought to a vertical position and held there by guy ropes. The hammer, on its sliding carriage, is lowered until the pile point strikes bottom. At that stage the hammer is completely submerged, although the spud is long enough so that its top is well above water level.

The first few blows of the hammer force the pile down through the toe piece, turning up the spikes and disengaging their grip. The hammer then follows the pile down into the water along the sliding carriage until the top of the pile



Here all but the upper end of the hammer cylinder is submerged. The agitation of the water is caused by exhausted compressed air rising from the open chamber at the bottom of the hammer.

reaches grade. During the progress of the hammering, the hose connection carries compressed air to the bottom cylinder and serves to equalize the water pressure when the hammer is submerged. In other words, as the pile goes deeper more air pressure is needed to keep the water out of the cylinder. This prevents water from interfering with the reciprocating movement of the ram.

As this new type of hammer uses piles cut to size, it makes it possible to drive them to exact grade, and thus obviates the work of sawing off any excess lengths under water.

ICE PRODUCED BY NATURAL EVAPORATION

AT Durango City, which is situated in southern Mexico at an elevation of 6,000 feet and close to the northern limit of the torrid zone, ice is produced in a unique and original way. The National Geographic Society tells us that when the *maguey,* a century plant, has reached the blooming stage, and its bud has been tapped for *pulque,* it is usually

Hammer rigged up to follow pile down under water. The pile has been set in the cup-shaped anvil block of the hammer, and all is ready to begin driving.

destroyed. At Durango, however, all the plants are placed on straw-covered ground, and the leaves are laid out with their cupping faces upward. Into each leaf is poured about two quarts of water.

Although the temperature is not low enough to freeze water standing in the open it does freeze the water in the *maguey* leaves. The ice so obtained is gathered in the early morning and thrown into ice houses, where it freezes into a solid mass—as loose ice in contact always does. Later it is cut out and sold to the cheaper trade. No explanation is offered as to the freezing. Scientists assume that the leaves, being shallow and having all their surfaces exposed to the air, are subjected to excessive evaporation and to the consequent cooling that naturally occurs at such altitudes.

The remarkable growth in air traffic between Great Britain and the continent is indicated by figures recently published in *Lloyd's List and Shipping Gazette.* During 1923 there was carried by airplane a total of 45,531 passengers, of which 73 per cent. was transported in English flying machines. In this connection, it is interesting to note that the average load of the British airplane was increased from 810 pounds in 1922 to 1,200 pounds in 1923.

Pneumatic Apparatus Speed Up Performance in the Foundry

How Vibratory Motion, Induced by Compressed Air, is Instrumental in Doing Many Useful Things

By S. G. ROBERTS

SAVING time and money through the medium of compressed air has been made possible by a number of pneumatic appliances devised by the Malleable Iron Fittings Company of Branford, Conn. What has been done by this enterprising New England concern should be a matter of interest not only to the foundry industry in particular but also to other departments of our busy life in which some of these equipments can be utilized to advantage.

THE Malleable Iron Fittings Company of Branford, Conn., began business back in 1865 when things could be done in a more or less leisurely fashion and when costs were relatively low. As time went on, being responsive to developing opportunities, the concern amplified its facilities and correspondingly augmented its activities so as to contribute effectually to the needs of a greater number of customers.

Today, this up-to-date plant is turning out iron, steel, brass, and aluminum castings for diversified purposes; and it has specialized in the making of identical commodities in large quantities. To succeed in this field of service, which is a highly competitive one, the Branford company has been confronted with a twofold problem: it had to skimp in the quality and the finish of its products or to find ways to reduce manufacturing costs so as to maintain the firm's long-established trade standards.

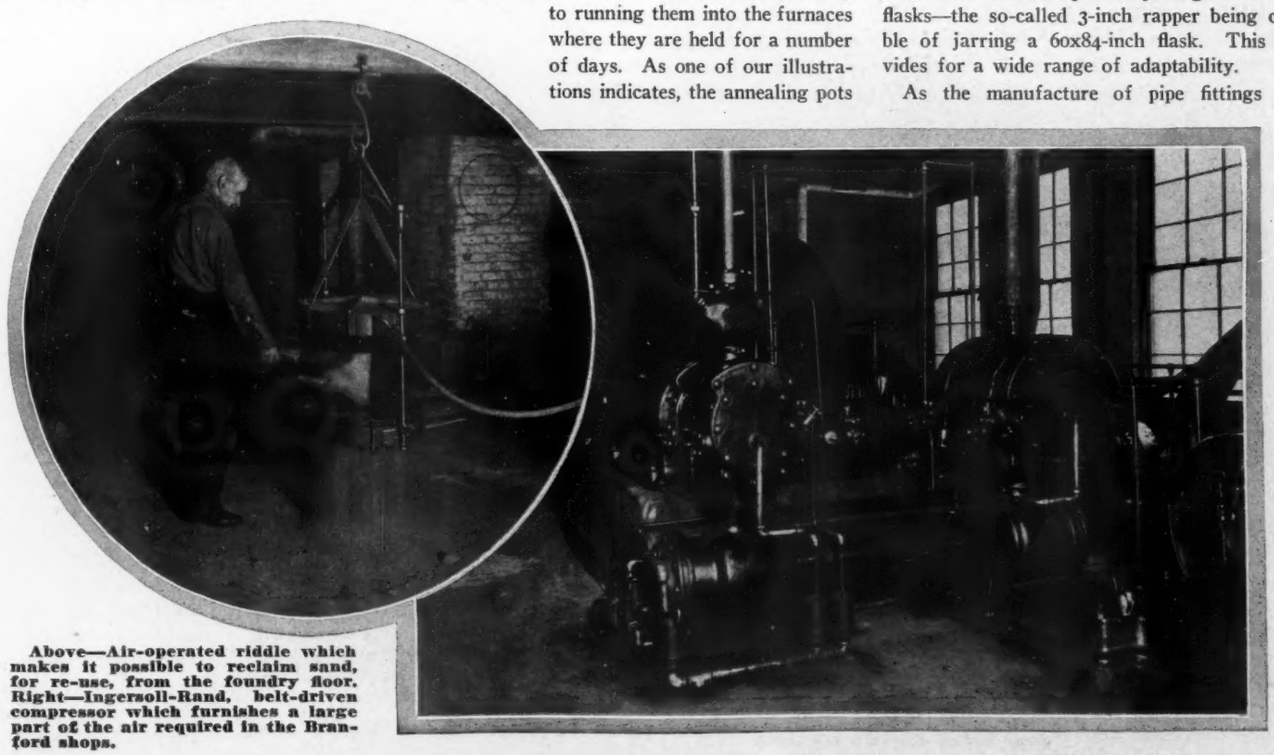
Wisely, the management elected to pursue the latter course; and to this end it has brought out at intervals ingenious auxiliaries capable of lightening labor and of doing better work more quickly than it could be performed by hand. Having proved these facilities well worth while in their own shops, the company has engaged in their manufacture for use in other foundries and kindred undertakings. The purpose of the present article is, therefore, to explain briefly how these devices are employed at Branford and, by doing this, to indicate how they may be of service elsewhere—always assuming that compressed air is available to operate them.

Among the commodities produced in large quantities at Branford are pipe fittings of various sorts and sizes. At the start, these are hard, iron castings, totaling daily approximately twenty tons. To transform these castings into malleable iron they must undergo annealing at a prescribed heat for a suitable period; and to effect this the castings must be properly packed in annealing pots preparatory to running them into the furnaces where they are held for a number of days. As one of our illustrations indicates, the annealing pots are sectional affairs, placed one on top of the other, that are successively loaded with castings enveloped in a packing of annealing material.

The practice in many shops is to place the castings in the pots by hand and then to cover them with packing. This procedure takes a good deal of time and requires considerable training on the part of the workman to insure a proper job. By using an annealing-pot rapping vibrator, an air-driven apparatus, the packing is thoroughly jarred down—the packing being shoveled in while the vibrator is in action. The packing can thus be handled more rapidly and better than by the old way; and the life of the pots is prolonged because it is not necessary to hit them with mallets to cause the packing to settle. As a matter of fact, when small castings are dealt with, the castings can be shoveled into the pots, as is the packing, thereby cutting down labor.

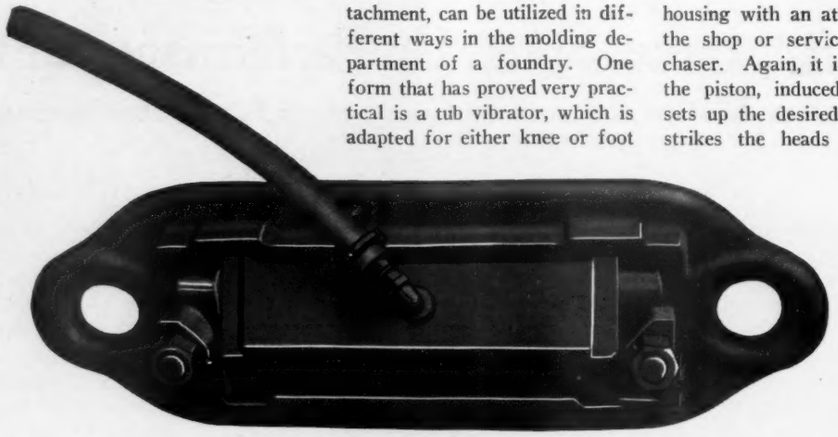
The vibratory action of the rapper is induced by a reciprocating piston which alternately strikes the opposite heads of the appliance; and, depending upon the size of the vibrator and the air pressure, the piston makes anywhere from 1,600 to 4,900 strokes a minute. Again, agreeably to the size of the rapper, from 1½ to 32½ cubic feet of free air per minute are consumed when working continuously with air at a pressure of 60 pounds. These vibrators are designed to meet the different conditions imposed by large and small flasks—the so-called 3-inch rapper being capable of jarring a 60x84-inch flask. This provides for a wide range of adaptability.

As the manufacture of pipe fittings con-



Above—Air-operated riddle which makes it possible to reclaim sand, for re-use, from the foundry floor. Right—Ingersoll-Rand, belt-driven compressor which furnishes a large part of the air required in the Branford shops.

stitutes a considerable part of the work of the foundry and associated shops, it follows inevitably that the molding, casting, and finishing of these commodities necessitate the employment of various labor-saving and time-saving equipments; and in the operation of these compressed air is more or less conspicuous. One of the features in this department of the plant is the preparation of a great many cores of sizes requiring exceedingly careful manipulation in their forming. This can be readily understood when the reader is reminded that thousands of these castings are small and are extensively utilized in the building of automobiles. The cores for these pipe fittings are fashioned by dexterous coremakers who do their work on vibrator core benches which have been developed for the purpose by the designers of the plant.



Double-eye, knock-out vibrators of this type are capable of dealing with large flasks.

This type of core bench is provided with a vibrating platen of thin steel which is set in the middle of the bench. The platen is supported by springs and is mounted on a frame. On the underside of the platen, and attached to it, is a pneumatic vibrator which operates on the principle already described in the case of the annealing-pot rapper. The size of the vibrator is suited to the nature of the work; and the valve controlling the vibrator is so arranged that a slight downward pressure on the platen serves to open the valve and to bring the apparatus into play. That is to say, when the coremaker has made his core he has only to press down on the filled core box to set the vibrator in motion. This motion frees the core from the mother box—which is removed—thus leaving the core in the drier and ready to be sent to the oven. It is claimed that the use of this bench—besides speeding up production—obviates pounding on the core boxes and greatly reduces the number of sprung and broken core boxes. Vibrator core benches of this description can be used to advantage in producing cores for pipe fittings, valves, cocks, hardware, automobile parts, and in turning out cores for many other kinds of small castings. A vibrator platen of this type can be attached to any bench already in service and not yet fitted with one of these helpful air-driven devices.

Small pneumatic vibrators, modeled more or less after the core-bench attachment, can be utilized in different ways in the molding department of a foundry. One form that has proved very practical is a tub vibrator, which is adapted for either knee or foot starting—the pressure of the worker's knee or foot sufficing to open the valves in the air line and to set the vibrator in motion. This arrangement leaves the molder's hands free to continue his work uninterruptedly. As an adjunct to pneumatic jarring or ramming tables, the Malleable Iron Fittings Company has brought out some very small vibrators which can be used to vibrate pattern plates or frames. These vibrators are miniature forms of the annealing pot rapper, and are attached to plates or frames and operated by foot or hand valve.

Another variation of the vibrator is called the "continuous operating type," and this can be had in eight sizes. This apparatus is susceptible of a rather wide range of employment, and is recommended for use on bolting screens, on sand-blast dust-collector screens, on hoppers on sand screens, on sand-blast hose machine hoppers, on chutes utilized for feeding coal, molding, and core sands, and for many other similar services required in and around foundries and generally in connection with material-handling machinery. The vibrator, itself, is fashioned of hardened and ground steel, and is mounted in a low-carbon steel housing with an attaching lug formed to meet the shop or service requirements of the purchaser. Again, it is the reciprocating action of the piston, induced by compressed air, which sets up the desired vibrations when the piston strikes the heads or ends of the enclosing cylinder.

Two years ago the company brought out a pneumatic vibrator riddle, which consisted in the main of a sieve suspended on a vertical arm carrying, as a counterweight, a small, horizontal, air-driven vibrator capable of causing 1,800 vibrations a minute. This was designated as Type A. Excellent as that appliance proved to be, still the company has been encouraged to develop a turbo-vibrator riddle, which is known as Type B. A photograph of this riddle in action forms one of our illustrations. This pneumatic foundry auxiliary is designed to take the place of electric riddles which are obliged to work in the foundry under exceedingly adverse conditions. That is to say, the electric motor is apt to draw dust into its field, thereby leading to short circuits and to excessive wear on brushes and armatures.

The turbo-vibrator riddle is actuated by an air-impelled turbine, which is completely encased. The turbine is weighted out of balance a predetermined amount, and the effect of this weighting is like that which would be produced if the wheel were suspended eccentrically. For heavy work, the turbine is actuated by compressed air issuing from a ⅛-inch nozzle, while for ordinary demands an air jet of 3/32-inch, at a pressure of 60 pounds and upward, is ample to insure satisfactory results. By mounting the turbine on two ball bearings, packed with grease, the manufacturers declare that the riddle will run for years without attention. They have found that the riddle will handle core-room sweepings as easily as foundry sand. Previously, the waste sand from the core room was scrapped, and represented a considerable loss in the course of a year.

Corner of the core room where compressed air jets are used to blow the molds clean before forming the cores.

The Malleable Iron Fittings Company has given considerable attention to the development of knock-out vibrators; and variations of this adjunct have been devised capable of dealing with different problems of the foundryman. They can be used singly and in pairs, and they are equipped either with eyes or with keyed trunnion jaws to facilitate attaching them to slings and to the trunnions of flasks. The

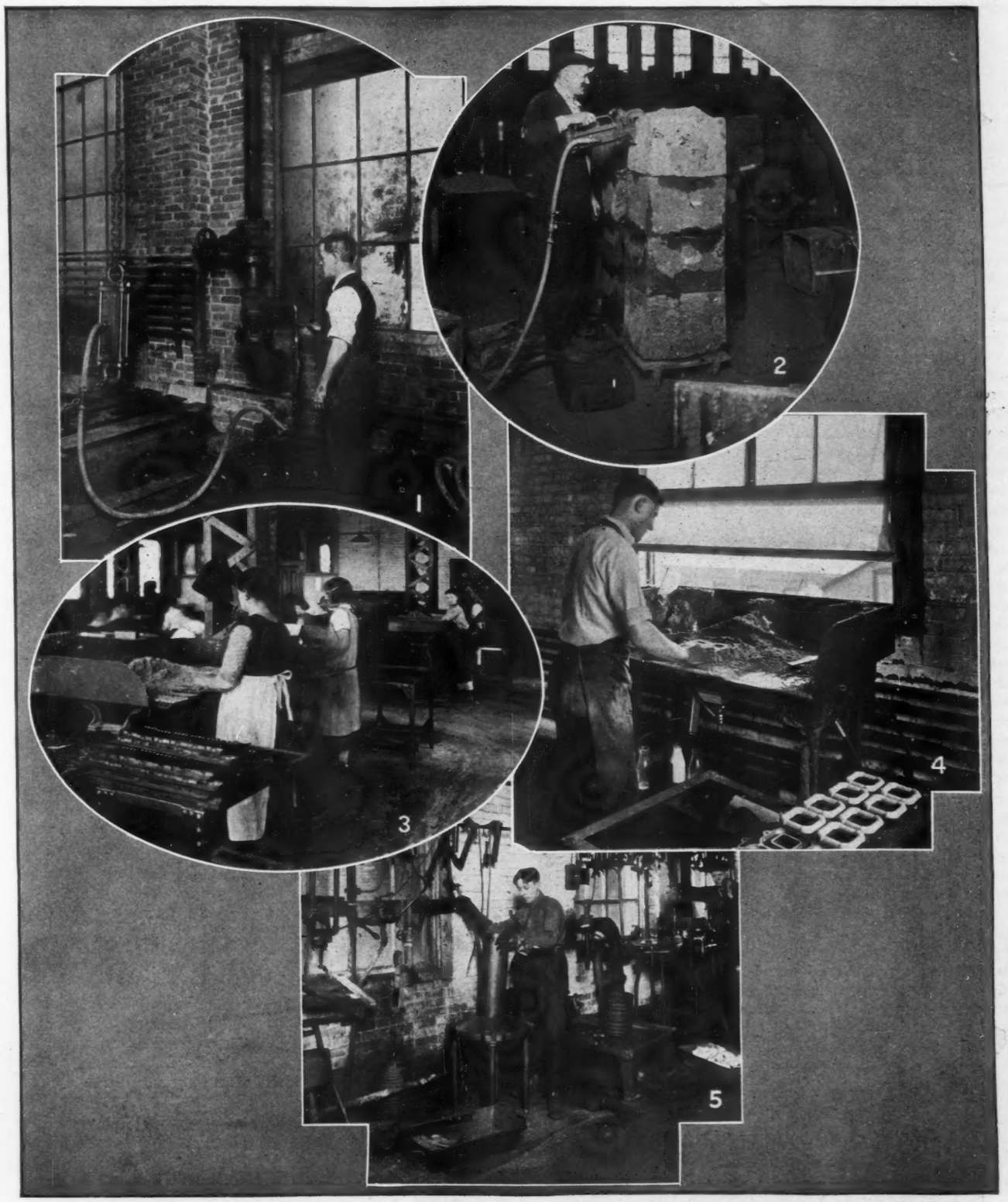


Fig. 1—Double-eye, knockout vibrator secured by a single sling to a flask and supported from a traveling crane.
Fig. 2—Pneumatically operated annealing-pot vibrator which can be quickly put in position and started.
Fig. 3—Battery of vibrator core benches which turn out daily a large number of cores for small pipe fittings.
Fig. 4—Close-up of a vibrator core bench showing the vibrator projecting downward from the underside of the platen.
Fig. 5—Vibrator, charging-can loader in action.

Fully equipped Branford sprayer and cleaner which has proved to be a very adaptable pneumatic tool.

knock-out vibrators are made in several sizes; and two of these apparatus have knocked out a 2,000-pound casting from a 10x8-footx30-inch flask in 3½ minutes with the help of only one man. It is unnecessary to hammer or pound flasks when vibrators are used; and the life of flasks is lengthened accordingly.

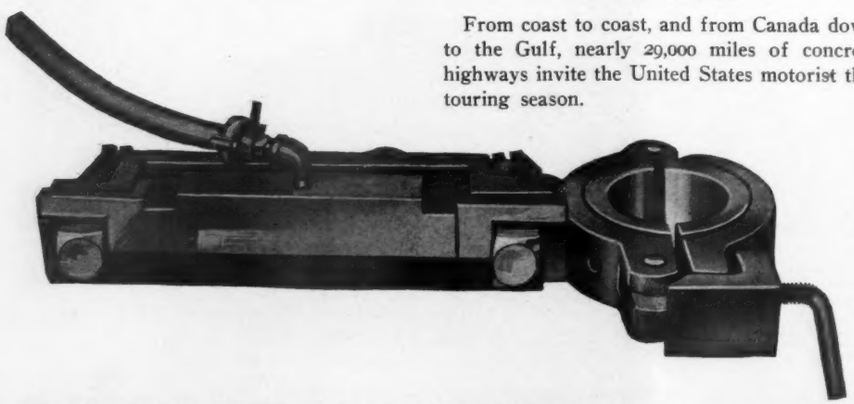
Every foundry working in collaboration with machine shops is expected, when practicable, to remelt scrapped material in the shape of milling chips, drillings, borings, etc. From the very nature of metal in this form there is generally a tremendous waste due to oxidation while in the cupola or furnace unless the material be briquetted or otherwise compacted preparatory to remelting. The Malleable Iron Fittings Company has overcome this difficulty by developing a vibrator charging-can loader. The apparatus, shown in one of the accompanying illustrations, consists fundamentally of a circular table, mounted on four legs, equipped with a pneumatic vibrator secured to the underside of the table. Sheet-metal cans are successively placed on the loader and charged with small scrap—the vibrator being set in motion to pack the stuff into the container. The vibrator does its work well and quickly; and when the chips, borings, etc., have settled far enough, the can is sealed by a disk held in place by crimping or hammering inward the top edge of the cylinder. It is claimed that the air-driven loader increases the weight capacity of a can fully 25 per cent. over that possible with hand tamping. The cans, when placed in a cupola or furnace, hold together until the absolute melting point is reached; and we are told that loss by oxidation is negligible.

In the bending of pipes it is often the practice to fill them first with sand—rapping on the piping the while to cause the sand to settle and to pack itself. For operations of this sort the Brandford company has produced a pipe-rapping vibrator, which can be quickly secured to a pipe wherever desired. The action of the pneumatic vibrator tamps the sand, does away with the services of at least two men, and performs the work in half the time that it can be done manually.

It is not possible, in the space available, to go further into detail or to cover all the air-driven equipment manufactured by the Malleable Iron Fittings Company; but before concluding our brief survey of that concern's activities let us say a few words about the Branford variable jet cleaner and sprayer. This pneumatic appliance is a combination tool that has been found fit for many uses in the foundry, the machine shop, and elsewhere. By varying the size of the jet, the sprayer is able to handle paints, lacquers, enamels, gasoline, kerosene, machine oil, whitewash, silica wash, fire clay, etc. Similarly, the sprayer can be utilized either as an air-blast cleaner or a suction cleaner by recourse to suitable attachments and tips.

Valve and adjustable nozzle for Branford pneumatic cleaner and sprayer, which is equipped to produce a variable jet.

From coast to coast, and from Canada down to the Gulf, nearly 29,000 miles of concrete highways invite the United States motorist this touring season.



Vibrators of this pattern are intended to pack sand in piping preliminary to bending.

DAMS THAT WILL NOT STOP THE SALMON

THERE are several important rivers on our west coast and in Alaska where power dams are being strenuously opposed by those interested in the fish industry on the ground that it would stop the run of salmon. Considering the vast quantities of fish that are caught and commercially distributed all over the world, the opposition would seem to be fully justified. However, means have apparently now been found to dispose of the difficulty and to satisfy all concerned.

The United States Bureau of Fisheries has heretofore believed that fish will not pass a dam more than 30 feet high, regardless of the number of fishways. This opinion is said to have been revised after some experiments in California, where large schools of fish have passed dams of considerably greater height. This has been made possible by providing a series of "resting pools," so that the salmon do not have to make the long climb in one uninterrupted effort.

GAGING SPEED AND POWER OF PIGEONS

SOME attempts have been made recently to determine the speed of flying pigeons and the power exerted by them in flight. The pigeons, as they flew, were made to unwind a thread from a reel—the rotations of the reel being automatically recorded. The time, in fifths of a second, was also registered simultaneously; and a Prony brake, acting on the reel, gave the pull.

The work done by the birds in a second ranged from .36 to 1.29 kilogrammeters. The work per second for one kilogram of the weight of the pigeons varied from .73 to 2.63 kilogrammeters. The largest of these quantities corresponds to a rate of one-thirtieth of a horse-power per kilogram. There was no reason to assume that the birds were doing their best. It was, indeed, remarked that "the animals manifested a certain repugnance to flying under these conditions."

POWER FROM THE TIDES

SO many schemes are now announced for utilizing the flow of the tides for power development that we may reasonably hope to see one or more of them come to fruition. The most completely planned project seems now to be one in France, on the estuary of the Aber-Vrach in Brittany, where the tidal range is approximately 25 feet.

The principal part of the plant is to consist of a barrage, 450 feet long, with four groups of turbines driven by both the incoming and the outgoing tides. The power generated will vary from 75 to 1,200 H.P.; but, when operated in connection with a regulating plant higher up, it will be possible to produce a minimum, constant output of 1,200 H.P. and a maximum of 3,200 H.P. The preliminary studies indicate that there will be an annual production of 11,000,000 kilowatt-hours. The estimated cost is 28,000,000 francs.

Canadian Brewery Installs Electrically Driven Refrigerating Equipment

By F. A. McLEAN

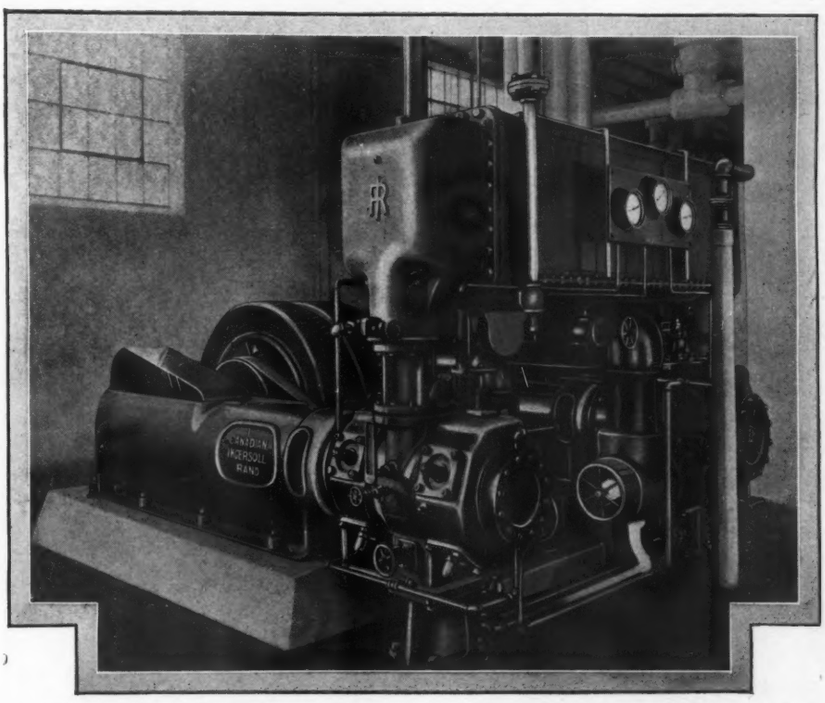
THERE are probably few industries in which refrigeration plays a more important part than in the modern brewery. The design and the equipment of such plants have been carried to a high state of development, particularly in Eastern Canada where a number of very large and up-to-date breweries are now in operation. Of the latter, Molson's Brewery in Montreal is, perhaps, a typical example.

This establishment, which annually produces 650,000 barrels of beer, recently decided to increase the capacity of its refrigerating plant by installing a Canadian-built 15 and 10½x16 inch Class PREA-2, direct-connected, duplex, 2-stage compressor with a water-tube intercooler.

This unit, which is driven by a Canadian Westinghouse, 325-H.P., 2,200-volt, 3-phase, 60-cycle synchronous motor, has a piston displacement of 727 cubic feet per minute, and under normal conditions—that is, 20 pounds suction and 185 pounds discharge pressure—delivers 610 cubic feet of free gas per minute. Expressed differently, under these service conditions the capacity of the compressor is equivalent to 180 tons of refrigeration.

Hand-operated clearance-control pockets permit running the unit efficiently at three-quarters or half load to suit the varying demands for refrigeration at different hours of the day or from week to week. In fact, as will become more evident later on, the load changes so much at certain seasons of the year that a compressor of variable capacity is almost a necessity. The clearance-control system for regulating the capacity of ammonia compressors makes it possible to economically take care of reduced winter loads or to operate with high or low-suction pressures whenever desired. It also permits starting and stopping the compressor in gradual steps. This results in less severe motor duty, and likewise eliminates fluctuations in the power lines that might otherwise be caused by throwing the load "all on" or "all off."

The Molson plant is also equipped with a 75-ton, motor-driven ammonia compressor, which is operated when the demand is light, and with two 75-ton, steam-driven units for stand-by purposes. All four machines are connected to a common discharge header which, in its turn, is connected to all stands of the atmospheric condenser. Three suction lines are led into the header, which is in front of the intercooler. One of these lines comes from the low-temperature storage room, another from the high-temperature storage room, and the third from the beer cooler. The beer-cooling service is intermittent; but, when in operation, constitutes a very large share of the total refrigerating load.



Direct-connected, duplex, 2-stage, ammonia compressor equipped with a water-tube intercooler. The machine has a refrigerating capacity of 180 tons.

For a part of the year the high-temperature storage rooms, fermentation rooms, and beer coolers do not require much refrigeration from the ammonia system. The fermentation rooms, however, must be kept at a constant temperature, and this means that they must be suitably heated when the exterior atmosphere is too cold. The beer cooler is chilled both by water and by ammonia so that when the temperature of the cooling water is sufficiently low to perform this work properly there is no need to draw on the ammonia refrigerating system. The cooler is used for about three hours after each brew; and in extremely warm weather this service constitutes the peak load placed on the refrigerating system. Because the service is intermittent, the variable-capacity feature of the Ingersoll-Rand ammonia compressor is admirably adapted to the work. In order to simplify operations at the Molson plant as far as practicable, all refrigeration is carried at one common suction pressure. This, of course, fluctuates somewhat because of the changing demand of the beer cooler.

An outstanding feature of the new compressor is the special counter-current, water-tube intercooler for cooling the gas between stages. This intercooler is located directly over the high and the low-pressure cylinders. The water inlet is at the bottom, on the left-hand side, and the outlet at the top, to the right. Baffles are placed in the gas heads for the purpose of giving free passage to the ammonia gas which starts at the right and flows back and forth until it finally enters the high-pressure cylinder to the left. The point to be brought out here is that with such a water-cooled intercooler an actual saving in power of from 5 to 12 per cent. per ton of refrigeration is possible—the saving depending, of course, on the operating conditions, on the temperature and the quantity of water available, and on the initial superheat in the suction gas. The colder the water the more substantial the economies to be effected.

Cooling water for the cylinder jackets and the heads is taken from the city mains, while that for the intercooler and the ammonia condenser comes from a deep well. The latter water contains a considerable quantity of scale-forming constituents. For this reason the intercooler shell is square in section with removable bottom and sides to facilitate cleaning the tubes. This scale, as it collects on the intercooler tubes, is ordinarily soft and slushy; but if it dries—as sometimes happens on certain portions of the ammonia condenser—the deposit becomes hard and cement-like. A large valve in the center of the bottom of the intercooler shell permits draining off the sludge from time to time after it has been brushed from the tubes.

The new unit is provided with three gages, as can be seen in the accompanying illustra-

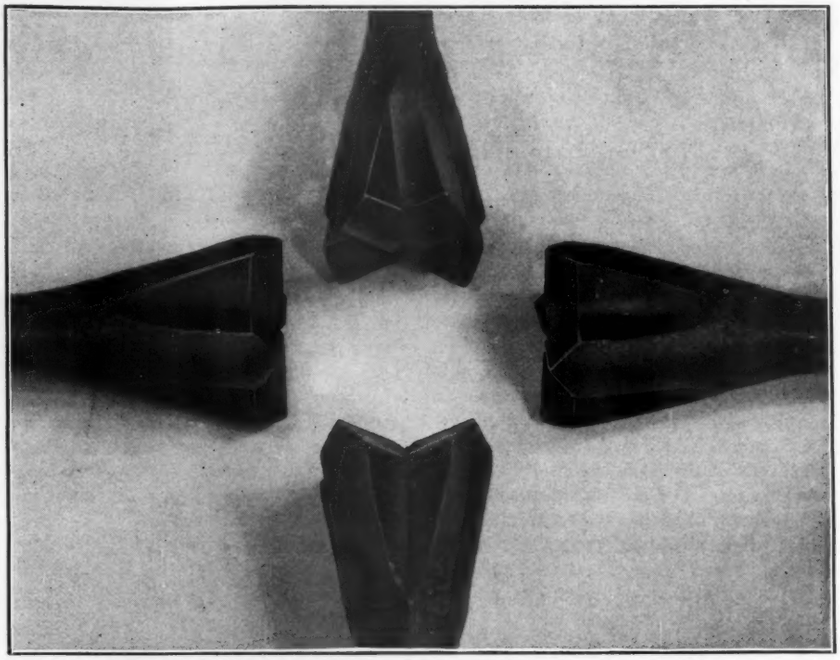
tion, for indicating suction, intercooler, and discharge pressures. The intercooler gage offers the operator a very simple and yet effective means for detecting whether or not the valves of the compressor are operating properly. For any given suction pressure or discharge pressure there is an associate intercooler pressure, and this should be maintained. If one or other of the valves of the high-pressure cylinder should leak at any time the intercooler pressure gage would immediately show that the intercooler pressure is too high. Similarly, if anything should happen to the valves in the low-pressure cylinder, the intercooler gage would register a pressure that is too low to suit the given suction and discharge pressures.

POOR BITS ON DRILL STEEL

By H. S. BRAINERD

AT THE present time, considerable attention is being paid to the efficient drilling of rock. The drills are being improved; more care is exercised in the manufacture of drill steel; and all precautions are being taken to see to it that the most rock is drilled in the shortest possible time and with the least amount of compressed air. However, if little or no heed is given to the bits, themselves, all the other efforts made are unproductive. In other words, no matter how efficient the compressor, how fast the drill may operate, or how good the drill steel, the bit must be properly shaped and hardened to insure the best results.

The 14° and 5° "double-taper 4 point" or cross bit with a 90° cutting edge has proved to be by far the most satisfactory for the greater percentage of rock work, although in a few places the Carr bit is still used for some work. The steels shown in the accompanying photograph were returned from a mine, in which Carr bits are still used, with the complaint that they were defective—having failed in a short time. The reason for their failure can easily be seen. These particular steels failed from fatigue induced by reason of poor bits—that is, the steels had to absorb the entire impact or shock of the drill blows, thus causing failure.



Perfectly shaped, 4-point bits such as these have been found best suited for most rock work.

A drill-steel survey, made by the United States Bureau of Mines in coöperation with the Bureau of Standards, showed that the drill steel was the most neglected part of mining equipment and indicated that too much attention could not be paid to steels when in the blacksmith shop. It is there that most drill steels are ruined and condemned—in the majority of cases, unjustly.

No one familiar with a chisel would use such a tool if it had a flat cutting edge; and yet bits like those illustrated are far from uncommon. The two bits in the top of the picture are properly made Carr bits. If the simplest and most effective type of bit is selected—and that is the 4-point bit, as shown in the accompanying photograph, and if these bits are perfectly shaped with the correct angles, have plenty of clearance, and are heat treated properly, it is surprising how much longer the steels will last and how much lower their cost of up-keep will be.

With the exception of the two Carr bits, in the center at the top of the picture all of the other bits were sent in for examination, having failed in a short time. They failed because the steels were fatigued by reason of poor bits—the steels having been forced to absorb the entire impact of the drill blows.

IRRIGATION TO INCREASE INDIA'S FOOD SUPPLY

THE average annual production of foodstuffs in India amounts to practically 81,000,000 tons: the actual requirements of the population of 319,000,000 are 79,000,000 tons, leaving only a narrow margin in years of crop shortage. As an adequate food supply is at present of graver concern than even constitutional reforms, the irrigation commission is now pressing the matter.

The latest reports give the irrigated area in British India as slightly over 50,000,000 acres, or 13.7 per cent. of the entire cultivated acreage. Of this amount, approximately 23,000,000 acres are irrigated by canals, 7,300,000 by tanks, 13,000,000 by wells, and the remainder by other sources. A considerable part of the land irrigated by wells, however, is reported as inadequately served.

Irrigation projects dependent upon large rivers have brought approximately 9,000,000 acres under cultivation during the last twenty years; irrigation by wells, 2,000,000 acres in the last decade, while canals now building will add 10,000,000 acres in the near future.

INVESTIGATION OF PAINT

CONGRESS has been asked, by a special committee appointed by the Engineering Foundation, to appropriate a sum of $45,000 for the purpose of conducting an impartial and a non-commercial investigation into the character and the uses of paint—the work to be carried on by the Forest Products Laboratory. According to the Foundation, there is no authoritative, independent, or disinterested knowledge of the general problems involved and how best to solve them with due regard to the various climatic conditions prevailing throughout the country.

Just how vital this matter is can be gathered from the fact that we spend about $456,000,000 annually for paint, and that the value of the housing property alone to which it is applied is estimated at $45,000,000,000. The life of a well-built wooden house, so it is asserted, can be lengthened anywhere from 100 to 200 years by the use of the proper kind of paint.

CUTTING DOWN COST OF FINDING GAS LEAKS

PUTTING test holes in frozen ground and concrete pavements to detect gas leaks has always been a tedious task when it has been necessary to rely on jumper steel and sledges. Often, even though the leakage might be costly, it takes hours to make a single hole by this method; and the workers consider themselves lucky if the first test hole reveals the source of the trouble.

Formerly, the Boston Consolidated Gas Company did all its probing by driving a steel into the ground by hand, making the holes from three to four feet deep, and determining in this way the proximity of the leak. It took anywhere from 45 minutes to 1½ hours to put in each hole. This was an expensive procedure. In seeking to reduce the cost for this work it was found that by using a "Jackhamer," operated from a portable air compressor, seven holes could be drilled in but 35 minutes—first through from 6 to 10 inches of grouted pavement and then through 3½ feet of frozen ground. To accomplish this required the services of one drill runner and one compressor operator. However, if this same work had been done by hand it would have taken four men a full day of eight hours.

Similarly gratifying results were obtained by the Scranton Gas & Water Company. One operator, utilizing a "Jackhamer" with specially bitted steel and drawing air from a portable compressor, was able to drill holes in a few minutes that two men could not have put down in less than several hours.

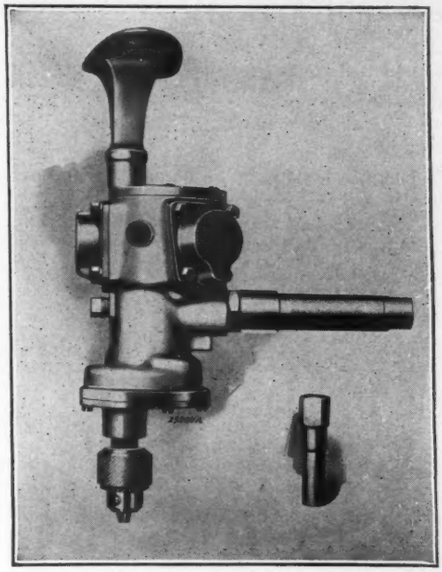
PHILADELPHIA-CAMDEN SPAN PROGRESSING

EVERY step in the progress of the erection of the suspension bridge across the Delaware River at Philadelphia is being watched with interest. In the early part of June, the first four of the temporary construction cables were stretched from tower to tower. Each of these cables consists of twelve 2¼-inch wire ropes; and when strung are to support the erection foot bridges for the workmen.

In carrying out the operations, the cables were paid out from reels placed aboard a barge; and as the latter was towed across the stream the cables were allowed to sink to the bottom. Their hoisting to the tops of the towers and the adjustment of the sag to the required height above the water level were accomplished a few days later. These cables will all be used in the permanent structure of the bridge, that is, they will subsequently be cut into the lengths required for the numerous suspension wires pendant from the main cables to the roadway.

The laying of the main cables will follow immediately upon the completion of this work. They are standing ready on numerous heavy reels and are being spliced into lengths sufficient for the span and the reach to the anchorages. The stretching of these cables and their symmetrical arrangement, together with the apportioning of the tension to each individual wire, are operations which cannot be hurried—they must be watched with patience.

Pneumatic "Jackhamers," drilling through pavement and underlying frozen ground, lighten the work of putting down test holes in search for leaks in Scranton's gas mains.



A tool that will prove useful in many fields.

NEW PNEUMATIC DRILL OF LIGHT WEIGHT

THERE has recently been put on the market by the Ingersoll-Rand Company, New York, a new, light-weight, pneumatic drill—known as Size D—that is suitable for drilling holes up to 9/16 inch in diameter and for reaming up to 5/16 of an inch.

This unit may be fitted with a breast-plate, a feed-screw or a grip handle, and by reason of this flexibility can be adapted to a wide variety of uses. Its features are similar to those embodied in drills Nos. 6 and 600, brought out by the same company about two years ago, and include a light-weight aluminum case; steel bushings cast in all the bearing holes and the throttle hole; renewable and interchangeable cast-iron cylinders; and a special 3-cylinder motor. When unfit for further service, any cylinder may be easily replaced; and it is claimed that the motor can thus be made as good as new at a moderate outlay. The rotating parts of the motor are accurately balanced, eliminating vibration and reducing wear and tear. The drill, when handled properly in the field, has proved to be economical in its consumption of air and low in cost of maintenance. Its principal characteristics are as follows:

Recommended working speed, at 90 pounds air pressure	700 R.P.M.
Weight, including breast plate and chuck	14 lbs.
Length of feed, with feed screw	2½ Ins.
Standard twist drill will drive	9/16 In.
Size reamer will drive	5/16 In.
Length overall, with breast plate and chuck	15 In.
Distance from side to center of spindle	1½ In.

What is believed to be the oldest-going industrial concern in the world, *Sore Kopparbergslaga*, in Bergen, Norway, recently celebrated its seven hundredth birthday. The company, founded in 1223 to extract copper from a mine in Falun, has been in continual operation since 1225; and the aggravating circumstance is that we cannot equal its record as long as it keeps going.

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—*Founded* 1896—

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EDITORIALS

SCIENTISTS RECONSTRUCT FOSSILIZED FOREST

THE DOINGS of Tut-Ankh-Amen and his people make up-to-date news compared with the graphic story which is in preparation by scientists in the State Museum at Albany, N. Y. There, with infinite care, is being reconstructed a typical forest such as flourished in the dim past of 300,000,000 years ago in what we now call North America.

By chance, when excavating rock in Schoharie County, N. Y., for the dam at Gilboa—forming part of the Catskill Water Supply System of the City of Greater New York, workmen brought to light the fossilized remains of trees which paleontologists declared, after due study, were not less than 300,000 centuries old.

At first, the excavators unearthed only the bases of the tree trunks, but subsequently, under the guidance of skilled geologists, there were revealed the branches of these stands of timber which covered the region in the ages long gone. Such was the revelation in 1920. Three years later a tireless paleobotanist, while on a fishing trip, discovered fossil imprints of leaf formations of the Devonian period. With these facts before them and with funds made available for the purpose, certain of the staff of the State Museum have been engaged for some months in reconstructing a section of a forest, using the actual fossilized tree trunks as a support for the painted and sculptured superstructure and background modeled in accordance with the data available. In those days, so we are told, the climate was a tropical one.

Dr. JOHN M. CLARK, director of the museum, has declared that the fossils are remnants of the earliest forest now known to man. Heretofore, theory and speculation have colored our conception of these prehistoric timberlands; but the finds in the neighborhood of Gilboa have furnished positive proof of both the existence and the characteristics of our primeval forests. The object lesson being created at Albany will be an awe-inspiring one and an invaluable page in the world's book of knowledge.

IS AMERICA A CREDITOR OR A DEBTOR NATION?

ASK ANY well-informed man if the United States is a creditor or a debtor country and he will probably reply: "Creditor, of course." Ask him why, and he will point to the big war loans to Europe that are still unpaid; to the immense excess of our "visible" trade balance—exports over imports, representing a bill of twenty-odd billion dollars—also still unpaid; and he will recall that over-optimistic exporters sold vast amounts of goods to Europeans, resulting in "frozen credits" which are not yet thoroughly thawed out. All that, to his mind, is enough to place this country in the creditor class, even though much of the credit is of a decidedly doubtful character. Technically, the well-informed man is right.

But, along comes Mr. HERBERT HOOVER and says: "No. We are a debtor nation;" and he goes into both visible and invisible items of trade balance to prove it. In this contention he is upheld by the *Harvard Review of Economic Statistics*. Again, technically speaking, these groups are right. If you take the stand that European nations will never pay their war loans—England, of course, being excepted; if you admit that those frozen credits will never be thawed out; and if you assume that all the invisibles are charged on the side where they properly belong, then the Hoover-Harvard contention is right.

The latter body asserts that, as a result of our foreign trade during the World War—when our goods were moving across the Atlantic about as fast as steamships could carry them and there was little return movement of freight—we are debtor to the tune of about $2,000,000,000! On the face of it, doesn't it seem strange that the trade of the years 1919-1920 turned out better for us and just about offset those two billions; and that the following three years, 1921-1923, put us back again into the debtor class to the amount of almost $1,000,000,000? And thus we stand today.

But invisible trade balances—more money going out than coming in—have always been adverse to the United States, and the war and the post-war periods have greatly exaggerated this situation. The invisible items taken into account are: balance of securities bought and sold; private loans made; remittances both ways; Red-Cross and other relief funds moving; money spent by tourists coming and going; and the to and fro movement of currencies. The Hoover-Harvard group has weighed all these things in reporting the United States a debtor nation as a result of the past ten years' trade.

But, included in all this, is a little item of gold. In the last decade we have imported, net, a little more than $2,000,000,000 in gold. Added to the stock on hand before the war, we now have a total of $4,250,000,000.

Now for the conclusion. Take the view of the well-informed man who sees a favorable or visible trade balance of twenty-odd billion dollars offset by a reasonable debit of invisibles. Believing that some of the Allied debt will yet be paid, this gold belongs, according to all the rules of trade, right where it is. According to the Hoover-Harvard view, gold should be leaving these shores just about as fast as ships can carry it; but, instead, it is coming in right along.

Perhaps this explains why bankers do not take so much stock in the Hoover-Harvard conclusions: they apparently haven't confidence enough in the debit balance, or in the stability of European currencies to part with this gold, or any large portion of it. Be this as it may, this gold remaining here idle—that is unproductive, is a constant menace that may cause another period of inflation.

AIR-DRIVEN TOOLS AUGMENT OUTPUT OF SALTPETER

WHATEVER other sources the world may have of essential forms of fixed nitrogen, the fact remains that the nitrate beds of Chile are the main reliance and probably will continue to be for a good many decades to come. Because of their location and other conditions, the mining of *caliche*, as the raw material is known in South America, has for a long while been carried on principally by hand labor. However, of late, methods have been altered in response to the introduction of modern rock-drilling apparatus especially suited to meet the requirements of that industry.

During the so-called "nitrate year" from July 1, 1923, to June 30, 1924, the production of *caliche* amounted to approximately 2,250,000,000 pounds; and this showing was aided measurably by the adoption of air-driven tools for drilling. According to an authoritative report issued recently by one of the big companies engaged in the work, a new era is dawning which will lead to a substantial increase in output and to a cheapening of the cost of production.

For instance, we read: "In the extraction of *caliche*, entailing one of the major costs, the company has introduced mechanical means which not only cut down costs but also reduce the sizes of the pieces—a matter of prime importance. The results achieved have been of appreciable value."

BETTER ALUMINUM CASTINGS

ALUMINUM castings are made now for thousands of purposes, and this is notably the case in fabricating automobiles. One of the problems confronting the manufacturer of castings of this kind has been to obtain products free from weakening blowholes caused by the inclusion of gaseous bubbles. The inventive mind has been busy in seeking ways to overcome this difficulty, and the *Christian Science Monitor* tells us that perfect aluminum castings can today be made, in fact are being made in large quantities in a plant of one of America's great automobile companies.

The journal tells us that bubbles and pockets are eliminated by forcing the molten aluminum into dies by means of air pressure. To quote: "The die is placed, like a lid, over the pot containing the metal. As the molten metal is forced upward into the die, the air escapes through minute vents at the top—all danger of bubble formation being obviated."

The foregoing description, though lacking in some particulars that would naturally appeal to the engineering mind, nevertheless makes it plain that compressed air is doing a very valuable service by disposing of defects which have caused the foundryman no end of annoyance and expense in the past.

A CORRECTION

"Aluminum Paint" was the title of a short notice appearing on page 874 of the May issue of this journal. This information was supplied by the Bureau of Standards, and stated that "the heat radiated from an aluminum-painted radiator is less than one-third that emitted by an equal area covered either with a non-metallic paint or enamel, or when it is simply allowed to rust."

The Bureau of Standards later corrected this statement and explained that, because heat dissipated from a radiator was largely lost by convection, the lower radiating power of aluminum paint had only a small effect upon the heating efficiency of an aluminum-painted radiator. In the Bureau of Standards' Technologic Paper No. 254 the following statement is made: "It is shown that, owing to the fact that house radiators are essentially convectors of heat, a gain of only 10 to 15 per cent. in heat dissipation into the room may be expected by covering the surface of the radiator with a paint which is free from flakes of metal; for example, aluminum or bronze."

Heating systems are designed with such a margin of capacity that this difference is usually not important, and may in many cases be outweighed by the marked advantages of aluminum paint for covering, hiding, and wearing on heated surfaces.

Real estate developments may soon wipe out Heathfield Hall, James Watt's old home in Birmingham, England. The house contains Watt's garret workshop, which has remained untouched since his death in August, 1819, although visited constantly by engineers. It is hoped that steps will be taken to preserve the Hall as a permanent memorial.

THE DEPTHS OF THE UNIVERSE, by George Ellery Hale, Honorary Director of the Mount Wilson Observatory of the Carnegie Institution of Washington. A book of 98 pages, with many illustrations. Published by Charles Scribner's Sons, New York. Price, $1.50.

NO thoughtful person can look into the starlit depths of the sky without a feeling of wonderment if not of bewilderment. As we move through space, other heavenly bodies also travel upon their ordered courses; and the factors of distance, speed, light, and magnitude are all measurements upon a tremendous scale. Although such has been the interrelation of celestial bodies for untold eons of time, still every now and then the patient, painstaking astronomer happens upon some new revelation.

The present volume deals with recent discoveries at Mount Wilson, which have vastly expanded our conception of the scale of the stellar universe and throw new light upon the evolution of the stars. Its chief contents include Adams' new method of measuring stellar distances and tracing the life cycle of giant and dwarf stars; Shapley's illuminating studies of remote globular star clusters; the recognition by Barnard of cosmic dust in the dark nebulae; and the discovery by the author and his associates of the curious law of solar storms.

WHAT INDUSTRY OWES TO CHEMICAL SCIENCE, by Richard B. Pilcher, O. B. E., and Frank Butler-Jones, B. A., A. I. C., with an introduction by Sir George Beilby, LL.D., F. R. S. A volume of 158 pages, published by Van Nostrand Company, New York. Price, $2.00.

THE present work brings to a focus a series of articles which were published in *The Engineer* (London) during 1916 and 1917 under the inclusive title—*What Industry Owes to Science*. Needless to remark, the aim really was to lay stress upon industry's indebtedness to the chemist. The subject matter justified remodeling and presentation in book form; and, in a dignified and entertaining manner, the broad facts of achievement have been brought out. The volume should prove worth while to the manufacturer and to the general reader.

TAXATION: THE PEOPLE'S BUSINESS, by Andrew W. Mellon, Secretary of the U. S. Treasury. A work of 229 pages, printed by The Macmillan Company, New York. Price, $1.25.

THE vast majority of the citizenry look upon the problems of taxation as matters quite beyond their ken, although they protest more or less loudly when the levy is laid directly upon them—no matter what is the amount they are called upon to pay into the coffers of the Government or the State. The theory of taxation is susceptible of elemental exposition; and the sooner the man in the street grasps the fundamentals of this phase of national economics the sooner will he be able to refute the often purposely misleading explanations of the men who represent him in the legislatures.

The well-being and the prosperity of all of us are involved in the equitable and the wise apportionment of taxes, and no one can escape the ultimate effect of either good or bad legislation in this department of our national life. Mr. Mellon has set himself the task of dealing with the subject of taxation in a simple and concise manner so that the veriest layman can grasp the workings of a system which touches the pocketbook of everyone sooner or later.

PRACTICAL MATHEMATICAL ANALYSIS, by H. Von Sanden, Professor of Mathematics at the University of Clausthal, and translated by H. Levy, M. A., D.Sc., F. R. S. E. A work of 195 pages, published by E. P. Dutton & Company, New York. Price, $4.50.

BASED on the work included in the author's courses in numerical and graphical calculation at the University of Gottingen, the present volume, offers the reader an able and stimulating survey of the methods by which the solutions of any given problem may be evaluated in a numerical form. The author has given preference to those methods which are capable of very general application in the teaching of mathematics and, consequently, has devoted considerable space to the treatment of empirical functions.

FOOD AND HEALTH, by Inez N. McFee. A book of 345 pages, suitably illustrated and published by Thomas Y. Crowell Company, New York. Price, $2.50.

IN THE days gone our ancestors satisfied their appetites first and thought only of their indulgence when gout and other painful maladies gripped them later on. The primary object of the housewife was to tickle the palates of the menfolk; and no one then dreamed about calories or suspected that invisible vitamines were intimately connected with the bodily well-being of humankind. Happily for us, all this is changed now; and it is within our power so to choose and to regulate our diet as to add measurably to our comfort and peace of mind and, incidentally, to our value to the community as ablebodied citizens.

Nine out of ten of our common ailments are caused by wrong foods or right foods used in wrong proportions. The author has dealt with her subject in an extremely sane and straightforward way, and she has presented her facts in a manner that all can understand and profit by. It is self-evident that no one needs to be too fat or too thin; and it is just as easy to avoid chronic dyspepsia or loss of appetite if we follow the rules laid down for us.

Air Filters for Compressors and Internal Combustion Engines is the title of an informative and well-prepared pamphlet lately issued by the Midwest Air Filters, Inc., Grand Central Terminal Building, New York City. Copies of this brochure will be mailed gratis to any interested applicant.

Sweden is now obtaining from her falling waters a total of 1,345,000 H.P.

LAUNCH OF OIL-ELECTRIC TUG "VAN DYKE I"

ON June 7, there was launched at the yard of the Staten Island Shipbuilding Company, Staten Island, N. Y., the oil-electric tugboat *Van Dyke I*. Boats of this character are at present novelties, inasmuch as there are but few of them in existence the world over. This particular vessel is one of three craft of the same sort building for the Atlantic Refining Company of Philadelphia, Pa.

Each of these tugs will be equipped with two Ingersoll-Rand, Price-Rathbun oil engines, each of which will be direct connected to a General Electric generator. The generators, in their turn, will furnish current for the operation of a General Electric motor secured to the single propeller shaft.

INTENSE COLD PRODUCES "HYDROGEN ICE"

WITH the temperature somewhere around 423 degrees below zero Fahrenheit, experts of the United States Cryogenic Laboratory have produced liquid hydrogen and, subsequently, converted some of it into so-called solid hydrogen. This is probably the first time in the history of the Bureau of Standards that its scientists have been able to make "hydrogen ice;" and the credit for this achievement properly belongs to Dr. C. W. Kanolt, who has designed a special, multiple-wall vacuum container by means of which it is possible to preserve liquid hydrogen for a much longer period than practicable with the older apparatus.

Gaseous hydrogen, which is the lightest known substance, is first compressed to 3,000 pounds per square inch. Then, by means of suitable apparatus and expansion, intense cold is induced progressively until the temperature drops to 423 degrees below zero Fahrenheit, at which point the gas is changed into a liquid. Once hydrogen gas has been liquefied, it is a relatively easy matter to convert it into a solid state by further reducing the temperature about 14° F. through the rapid evaporation of the fluid in a partial vacuum. The resulting solidified particles look not unlike flakes of snow or ice.

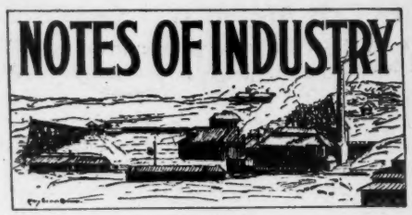
In the past, however, great difficulties have been experienced in liquefying the hydrogen gas, because any impurities in the gas, such as air, freeze solid long before the hydrogen liquefies, thus clogging up the apparatus and stopping the process. The temporary storage of hydrogen in any kind of a gas holder is, therefore, a troublesome matter, because gases are very apt to diffuse through the liquid seal used in the holder and become mixed with the hydrogen.

Experiments made at the Bureau of Standards on relative rates of diffusion of nitrogen through glycerine, machine oil, and water, have proved that the rate of diffusion through glycerine is very much lower than that through water or machine oil. This was to be expected because of the extremely low solubility of nitrogen and other gases in glycerine. Hence glycerine is now employed as a seal for the gas holder used for the temporary storage of pure hydrogen.

Both liquid hydrogen and solid hydrogen have been produced in the United States and abroad. However, the process as developed at the Cryogenic Laboratory promises to be the first which will make it possible to manufacture liquid as well as solid hydrogen on a practical scale.

Canada is today the second-best foreign market for American produce and manufactures.

Dr. C. W. Kanolt, of the United States Bureau of Standards, who has been able to solidify gaseous hydrogen by subjecting it to an ultimate temperature of more than 420 degrees below zero Fahrenheit.



The largest find of sapphires ever made in Ceylon has recently been reported from Pelmadulla. The gems, discovered in a small field at a depth of from 4 to 15 feet, include yellow, gold, purple, and blue stones of from 20 to 700 carets. Some of these sapphires weighed as much as half a pound.

French coal, iron, and steel production is now ahead of the pre-war levels, despite wartime destruction and an existing labor shortage. There are 140 blast furnaces in operation—a high record; and of the 22,015,111,500 gallons of water that flooded her coal mines nearly 18,701,250,000 gallons have already been pumped out. During 1923, these collieries produced 72 per cent. of the coal mined annually before the outbreak of hostilities. The railways, canals, roads—in short, all the means of transportation—are also almost entirely restored.

A total of 170,000,000 pounds of copper was consumed in the manufacture of automobiles, trucks, and accessories in 1923, or on an average of 50 pounds per car.

Great Britain is now producing fully 80 per cent. of her dyestuff requirements, which have been estimated to amount to about 21,000,000 pounds. This is in striking contrast to the pre-war situation, when that nation turned out but 20 per cent. of the dyes consumed by her. Besides, the manufacture of dyestuffs at that time consisted mainly of the coupling of intermediates made in Germany. England is now independent of her neighbor even in this respect.

A large passenger station planned for Chicago is to replace three of the existing terminals. The stations to be eliminated are the Dearborn, the Grand Central, and the La Salle, which together accommodate fifteen railroads. The complete plan also involves the straightening of a portion of the Chicago River and the opening of several streets.

The production of the ten millionth Ford car and its tour of the country from coast to coast are events worthy of note. We may expect various new developments in automobiles before the completion of the second ten million flivvers.

At the end of 1923, French navigable waterways had a length of about 7,472 miles, of which 3,262 miles represented canals. The freight movement on these internal watercourses amounted to approximately 33,000,000 tons in that twelvemonth. This is an object lesson to us who are so backward in developing our inland waterways.